TOPICS OF THE MONTH

More British machinery for Russia

EVIDENCE of the progress the U.S.S.R. is making with her plans for a big expansion of her chemical and other major industries can be seen in the steadily increasing flow of chemical engineering and other plant from Britain to Russia. Our ' Orders and Contracts ' column this month mentions British spray-drying plant and mixing machinery ordered from Moscow, while another recent example was an automatic heating and cooling plant for synthetic resin manufacture.

We have previously mentioned in these columns the £12½-million of machinery and equipment being supplied by a British consortium for the big new Russian tyre factory near Dneipropetrovsk; further orders for over £1 million worth of rubber-processing and other machinery have now been announced. Meanwhile, nearly six miles of rubber-coated *Terylene* conveyor belting—some of it over 6 ft. wide and 1 in. thick—has been sent off to the U.S.S.R. for use in a large iron ore field. Specially designed by B.T.R. Industries Ltd., it is made from special heavy fabric woven by John Bright & Sons Ltd. from some 376,000 lb. of *Terylene* supplied by I.C.I.

While British machinery and technical skill is thus helping the U.S.S.R., Poland, Czechoslovakia and related countries to fulfil their industrial development plans, the majority of American firms seem to be suspicious of any commercial approaches by the Soviet Union and show a general disinclination to do business with them. However, some recent increases in chemical deals between the U.S.A. and U.S.S.R. may influence American industry to yield a little and to sell them machinery and technical know-how as well as chemicals.

Fluorocarbons from coal

THE possibility of making stable transparent oils from coal at ordinary pressure in a single-stage process has been opened up by research in the British Coal Utilisation Research Association's laboratories. By reacting a low-rank coal with gaseous chlorine trifluoride diluted with nitrogen, good yields of highly halogenated products are obtained. Special precautions are necessary in the preparation of these products, and particularly in their collection.

The chief product is an oil (approximate analysis C 25%, F 65%, Cl 7%) having a wide boiling range (80% within 150 to 350°C. at atmospheric pressure). Smaller quantities of a thermoplastic resin and material of a waxy consistency are also obtained.

These highly fluorinated products have some properties similar to those of perfluorocarbons, *e.g.* marked thermal stability and chemical inertness, non-inflammability, high density, low surface tension and low refractive index; they are also extremely hydrophobic. Among possible uses the following have been suggested: high temperature lubricants, heat transfer media, dielectric fluids, hydraulic fluids, surface coatings.

The as yet uninvestigated gaseous products of the reaction may contain low molecular weight chlorofluorocarbons similar to those widely used as refrigerants and aerosol propellants.

Petrochemicals in Australia

WHILE the new Shell petrochemical plant at Geelong, Victoria, has already begun production of sulphuric acid (see ' World News ' this month) plans are being laid by American and Australian interests to make an even greater impact on Australia's petrochemical possibilities. Standard-Vacuum Oil Co., U.S.A., are concerned in a $50-million project involving four separate plants, to be located near Melbourne, with polythene, polystyrene and GR-S synthetic rubber among the chief products. Construction is starting straight away and it is expected that the plants will be in production by mid-1961.

The key unit will be built and operated by Standard-Vacuum's Australian affiliate, Vacuum Oil Co. Pty. Ltd., producing ethylene and butadiene from selected petroleum hydrocarbons processed at Stanvac's Altona refinery near Melbourne. Union Carbide Corporation's Australian affiliate will build a polythene plant. Another chemical company, still to be formed, will build a styrene plant. Both will be adjacent to Vacuum's petrochemicals unit which will supply them with ethylene. Styrene and butadiene will be used to make GR-S rubber in the fourth plant of the petrochemicals group.

Petroleum refining and petrochemical activities in Australia would undoubtedly be given a considerable further stimulus if appreciable deposits of crude oil could be found there. Exploration has been stimulated by Federal Government action, notably the subsidisation of stratigraphic drilling and extra tax concessions for participation in oil exploration companies. The Shell group has joined the search for oil in Western Australia, where slight traces of oil have been recovered near Derby. Delhi Australian Petroleum Ltd., Santos Ltd., and Frome-Broken Hill Pty. Ltd. have agreed on a joint drilling programme in the Queensland/South Australian border area. The Sun Oil Co. of California have started drilling near Maitland, New South Wales. Leases have been taken out or are sought covering some 80% of Queensland, as well as in the sea-bed along the Great Barrier Reef and the Gulf of Carpentaria. Following the oil strike at the Puri No. 1 well in Papua, B.P. and the Vacuum Oil Co., who had earlier announced their

intention of ceasing operations in the area, decided to carry on their share of the venture. It was recently reported that an American company was seeking a new permit to drill for oil in Papua.

Liquid natural gas comes by sea

BRITAIN'S first sea cargo of liquid natural gas arrived at Canvey Island, Essex, last month, aboard a converted tanker, the *Methane Pioneer*. It will be necessary for three or four more trial voyages to be undertaken before the technical and economic possibilities of this project can be fully assessed, but it has shown that it is technically possible for this gas to be transported over thousands of miles of ocean in liquid form at a temperature of –260°F.

The ship is jointly owned by the Gas Council of Great Britain and Constock International Methane Ltd., an American company which has carried out research and development work in this project for a number of years. The experimental load consists of 2,000 tons of liquid natural gas from one of the Gulf Coast oilfields. After liquefaction, which reduces its volume to 1/600th of the space occupied in gaseous form, it was loaded into five special tanks in *Methane Pioneer*. The tanks are aluminium with a 12-in. insulation of balsa wood and an outer jacket of steel. The liquid will be pumped through an insulated pipeline from the jetty to two storage tanks, each of which has a capacity of about 1,000 tons of liquid natural gas. One has been built for the Gas Board by Whessoe Ltd. and the other by the A.P.V. Co. Ltd.

There will be a continuous boil-off of gaseous methane from the liquid, and this material will be contained in a small gas holder of the dry-sealed Wiggins type, whence it will be pumped into the mains system. Liquid methane will be vaporised by heat exchange with water or steam, and there is no intention at this stage of making use of the refrigeration capacity of the methane. Conversion will take place under pressure which will be used to convey the gaseous methane into the Board's transmission lines. It will mix with gases from the Shell Haven refinery.

The town's gas is distributed at 500 B.Th.U./cu.ft., while the methane has a calorific value of 1,000 B.Th.U./cu.ft., and reforming will be carried out by the *Onia-Gegi* catalytic process. The reformed gas will be similar to coal gas with the additional advantage that it will be free from sulphur.

In its original state, natural gas is estimated to have an equivalent of approximately 530 therms/ton. Allowing for loss during the conversion and during the voyage it is estimated that the net value to the gas industry will be approximately 480 therms/ton. This is a relatively small quantity in relation to the demand for gas, though if the trials are successful, consideration will be given to building of vessels capable of carrying 30,000 tons in order to secure real economy.

An article by A. R. Myhill, F.R.I.C., M.INST.GAS E., M.INST.F., explaining the problems of importing natural gas, appeared in CHEMICAL & PROCESS ENGINEERING of January 1958.

Chemicals and raw materials in New Zealand

IN his article in our February issue, Mr. T. Hagyard commented on New Zealand's efforts to establish chemical industries based on indigenous raw materials, and dwelt at some length on the possibilities of calcium carbide manufacture in New Zealand. However, the majority of the raw materials used in New Zealand's expanding chemical industries to date have been imported. In spite of import restrictions, the country's intake of chemical raw materials did not show any appreciable reduction in 1958 and increases are probable in 1959 if local manufacture expands in order to produce end-products previously imported.

The value of the output of New Zealand's chemical and allied industries in 1957 was nearly £30 million, the principal products being fertilisers, paints, soap, toilet preparations, pharmaceuticals, disinfectants, weedkillers and pesticides. Production of fertilisers, mainly superphosphates, was valued at £10 million. The main raw materials imported for the fertiliser manufacturing industry are rock phosphate and sulphur and imports of these were valued at £1.2 million in 1957. Other minerals imported in substantial quantities are common salt and crude asbestos.

The principal imports of chemicals and allied products in 1957 were chemical compounds, valued at £4 million, of which a large proportion were antiseptics, sodium salts, detergents and acids; inorganic colours, (valued £0.5 million) and medical and pharmaceutical products (£3.1 million). Of this latter figure £1.4 million was imports of proprietary and patent medicines and it is likely that imports of these in 1959 will be much lower as more are made in New Zealand. Other important products for which licences are issued fairly freely are raw materials for the plastics industry, which is growing rapidly. Imports of thermoplastic and thermosetting resins were valued at £1.7 million in 1957 and this figure was certainly exceeded last year.

Oil refining with fuel economy

THE new, 11,000 tons/day crude oil distillation unit at the Shell Haven refinery in Essex has some interesting features, the most notable, perhaps, being the high degree of heat recovery employed so that fuel consumption will be some 30% lower than in previous designs. Besides this, a good recovery of light hydrocarbons is obtained by the use of a large, high-speed centrifugal compressor which receives all the uncondensed streams and delivers them to the gas fractionating columns. The unit employs over 40 centrifugal pumps, ranging from 5 to 450 h.p., all electrically driven and Buxton certified for Group II gases. Most of the pumps are fitted with mechanical seals. The one furnace employed is the largest single unit of its kind on any of Shell's U.K. refineries.

Costing, with tankage and ancillary equipment, approximately £6½ million, this unit just about doubles Shell Haven's distilling capacity to about 8 million tons p.a. With the addition of Stanlow, Heysham and Ardrossan refineries, Shell's total refinery capacity in the U.K. is now increased to some 15 million tons p.a.

Waste pickle liquor in ammonia production

A NEW use for waste pickle liquor from its steel-sheet galvanising mills has been found by the Tata Iron & Steel Co., India, who will use it for the treatment of coke-oven gas to yield ammonium sulphate, hydrogen sulphide, ferrous hydroxides and cyanide sludge. This process is being introduced at Tata's coking plant at Jamshedpur in connection with its current expansion schemes, now nearing completion, which are aimed at increasing crude steel production to 2 million tons p.a.

Developed at the instance of Tata Iron & Steel by the West German firm of F. J. Collin & Co., the process has been patented in a number of countries. The plant at Jamshedpur cost some Rs. 72 lakhs.

Russian literature and the chemical engineer

A DIFFICULTY, quite apart from that of language, that confronts the chemical engineer who wishes to follow developments in the Soviet Union, is that there is no Soviet journal specifically devoted to the subject. This absence of a Russian equivalent of CHEMICAL & PROCESS ENGINEERING may well be attributed to the fact that chemical engineering does not appear to be regarded as a specific branch of engineering in the U.S.S.R. This statement has been disputed, but no mention of the term 'chemical engineering' will be found, for example, in a recent book on Soviet scientific and technical education.*

Whatever the reason, the fact remains that papers on chemical engineering subjects appear in such a wide range of Soviet technical journals that any attempted list of journals most likely to interest the chemical engineer is bound to omit some important sources of reference. Such a list would not be complete, for instance, without mention of the Soviet journals devoted to oxygen production, the gas, petroleum, dairy, food and sugar industries, refrigeration, or of the transactions of various Soviet learned societies not specifically concerned with chemical engineering but often having important papers on the subject.

The language difficulty can, of course, be overcome by means of translations, and indeed there has been an increasing production in recent years of cover-to-cover translations of Soviet journals as they appear. Unfortunately for the chemical engineer, comparatively few of the journals of interest to him are translated in this way.

A correspondent who draws our attention to this state of affairs points out that, even if complete translations of all Soviet journals of chemical engineering interest were produced this would hardly be a convenient way of presenting the information available to the chemical engineer. Our correspondent suggests that, as there is no single Soviet journal of chemical engineering, it might be an idea for interested British and American chemical engineering institutions to synthesise one by putting together translations of selected papers from the Soviet literature. He suggests, further, that since English is much more widely understood as a language than Russian, some of the western European engineering organisations might also be induced to take part in this project.

We hardly think that this idea would work well in practice, one reason being that it would have to be an extremely well chosen editorial committee who could make a selection of papers which would meet with the approval of all parties. Apart from this, the mere stringing together of a collection of articles does not make a technical journal; a properly planned, balanced publication summarising the more practical advances in Soviet chemical engineering would be much more generally acceptable and the production of such journals is best left to experienced publishers employing professional technical journalists.

However, there is certainly a need for a more intensive collecting of *abstracts* from the Soviet chemical engineering literature; in Britain the Department of Scientific and Industrial Research has shown considerable energy in collecting translations from Russian scientific and technological papers and those organisations which felt compelled to do something about abstracts in the interests of chemical engineering might well collaborate to provide some sort of central abstracting and translation service.

*'Soviet Education for Science and Technology,' by A. G. Korol, Technology Press of M.I.T. and John Wiley, New York, 1957.

Future trends in welding

THERE is a very wide range of arc welding processes available to industry, a matter which has commanded much attention in recent years. Future trends indicate that there will be considerable simplification of this diversity of processes.

In a presidential address to the Institure of Welding, Mr. John Strong, chief executive director of British Oxygen Gases Ltd., said that he believed there would be a steady tendency to combine various processes to form something which was better than any one of the constituents. Examples of what had already been done lay in the use of CO_2 shielding with an automatic flux-covered electrode, and the use of gas shielding with magnetic flux, and the automatic flux-covered electrode working under a fused submerged arc flux. This tendency, entirely scientific and logical, needed to be pressed home. Perhaps, in time, instead of a dozen processes each possessing individual advantages over the others, we would have three or four.

Mr. Strong added that this would permit further rationalisation of automatic welding head designs and a greater standardisation of electrical power supply equipment. It was possible to see this coming now in the automatic and semi-automatic welding heads which would cater for four or more of the current processes, and a similar trend was appearing in the various forms of electric power supply. Handling gear, including jigs and manipulators, was also being steadily standardised.

In automatic welding also, Mr. Strong considered that we would see more and more of the complete welding installation and the complete machine.

Glass linings for industry

IMPROVEMENTS in glass have freed it from the limitations of size once imposed by structural considerations when manufacturing large-scale chemical plant, and wide use is now being made of a material previously confined to the laboratory. Basically, glass possesses properties which make its use in this type of work very suitable, namely good corrosion resistance, good abrasion resistance and its ease of cleaning. At the same time, the use of glass as a lining material for chemical plant, etc., has been confined to the glass enamelling of steel or cast iron.

During the past two or three years, however, progress has been made in the use of sheet glass as a lining to steel and concrete, the glass being adhered to the basic material of construction by means of mortars based on natural rubber latex/hydraulic cement compositions. An interesting article on the bonding of glass linings with these compounds has appeared in *Rubber Developments*.

The adhesion of latex cements to glass is of a high order and the strength of the bond, together with the property of flexibility, may be demonstrated by sticking two pieces of glass together (back to back) with a $\frac{1}{8}$-in. thickness joint of latex cement, allowing the cement to set and harden, and then subjecting one piece of the glass to impact. In an example of this property, two sections of toughened glass were joined together and, after four days, one face was subjected to an impact of 20 ft./lb. The upper section of glass crazed completely, following the normal shattering of toughened glass under impact, but the various segments still remained firmly bonded. In the case of the piece of glass on the underside, there was no crazing, due to the fact that the latex-cement jointing tended to cushion the blow.

For glass-lining work, however, toughened glass is not normally used, since due to its tendency to shatter it cannot be cut or worked, and thus every piece has to be cut to shape and size. The standard technique comprises the use of rough-cast glass which can be cut, and the reaction under heavy impact is similar, since, whilst the glass does not craze throughout, it does crack, but there is no loss of adhesion.

It was decided to try the application of glass as a lining for coal bunkers, coal chutes, etc., which handle finely divided fuel, and where the properties of corrosion abrasion and impact resistance and smooth surface were required. The first contract comprised the lining of the sloping walls of a 5,000-ton-capacity bunker of a steelworks. The actual lining comprised $\frac{3}{8}$-in.-thickness rough-cast glass ashlars bedded and jointed in latex cement, the average thickness of the mortar bed and joints being $\frac{1}{2}$ in. This bunker has now been operating for over three years and the glass lining has been completely successful. Since completing this work, bunker and chute linings have been carried out in electricity generating stations, collieries, steelworks and gas works.

This $\frac{3}{8}$-in. thickness of glass has also been found satisfactory for use in breweries, in such locations as bottling stores and filter rooms. In the chemical industry, this form of lining has been used in the protection of steel detergent storage tanks and steel acid tanks.

As far as the cost of glass lining is concerned, generally it is lower than that of acid-resisting brick or tile linings, but higher than that of gunned-concrete linings, or cement or asphalt renderings. Improvement in performance achieved in all cases, however, is considered to offset any increase in cost.

Haphazard quality control

EVEN in the present state of instrumentation and automatic control there is nothing to match hand, eye and brain for quality control in many industries. Inspection of filled ampoules for spicules is only one example of thousands of inspection jobs that have to be done ' by hand.' That being so it is extraordinary how casual some firms are in selecting and training inspectors. Some amazing facts were brought out at a recent conference on inspection arranged by the National Institute of Industrial Psychology. Inspectors were found to be recruited in many ways, mostly unsystematic. One firm engaged outside applicants, another promoted their skilled workers to the job, and yet another drew inspectors from their worst workers. It was quite usual in other firms to entrust quality control to people too old or inefficient for any other work. Training methods were equally haphazard.

Remedies of two kinds were suggested. First, inspectors should be chosen more carefully. Eyesight tests, simple intelligence and observation tests, and tests of manual dexterity have all been found valuable. The Institute have also devised a training scheme which is now being tried out at a new factory and seems to be giving good results.

The other line of action is to make the actual job of inspection easier. The conference agreed that it was a fatiguing task and the effort of fixing attention for long periods could lead to errors of judgment. Boredom could be avoided by giving the inspector rest-breaks or an occasional change of job. Supplying an inspector with regular information about the quality of his or her work had also been found a good stimulus to efficiency.

The staff of the Institute recommended that managements should give more attention to lighting and other working conditions for inspectors. Receptacles for products of different grades had been found helpful, for example, and so had closer regulation of the size of batch to be inspected. Where quality was measured by a needle on a dial, the tolerance limits could be made clear by colouring part of the scale. Unnecessary movements should be cut down. One girl mentioned at the conference had been found to be lifting her foot all day to use a badly-adjusted pedal, until the weekly total of her needless movements amounted to more than half the height of Mount Everest.

Next month's special feature:

MATERIALS OF CONSTRUCTION

Explosion Protection in Industry

By H. R. Maisey, A.M.I.E.E.

(Manager, Industrial Explosion Suppression Department, Graviner Manufacturing Co. Ltd.)

In past issues of CHEMICAL & PROCESS ENGINEERING *some details have been given of techniques which have been developed in Britain for the detection and suppression of explosions in industry. This article explains where and how these techniques are applied and gives striking evidence of their effectiveness in a variety of industries.*

DURING the last few years the techniques pioneered by the author's company, which are now widely used, have successfully suppressed or controlled some 35 explosions. The accompanying table summarises this experience, all the incidents being recorded between July 1954 and January 1959. In no instance was any explosion or fire damage caused to the plant protected and in all cases the plant was in operation again within a few hours of the incident, as soon as reconditioned protection equipment had been fitted. Insurance companies have met the cost of reconditioning. This highly successful record has prevented a property damage loss of several hundreds of thousands of pounds at a cost of about £3,000.

Such is the speed of operation of these methods that it is usually difficult to find traces of burnt material and the fact that there has been an explosion has often to be deduced from other factors such as pressure diaphragm collapse, the operation of independent relief valves, the expulsion of dust from relief vents, hand sieving the residual material, the presence of foreign bodies which have been overheated, or the more obvious mechanical failure of rotating machinery, such as grinder blades coming adrift.

Summary of Explosion Protection Experience

F. W. Berk & Co. Ltd., St. Albans *Micronizer* grinder and bag filter collector Material: Sulphur	Seven incidents. Some caused by flints, others by static electricity
Cooper, McDougall & Robertson Grinder and hopper collector Material: Sulphur compound	Five incidents, initiated between a worm and its casing, causing fire and explosion in grinder and worm conveyor
Sulphuric acid manufacturer Grinder and cyclone collector Material: Pyrites	Three incidents. One caused by blow-back and two for reasons unknown
Grangemouth Wood Flour Milling Co. Grinder and cyclone collector Material: Wood flour	Seven incidents. Four ferrous metal. One stoppage of feed with overheating. One fire in grinder and one for reasons unknown
Robert Lamb (Wood Flour) Ltd. Grinder and cyclone collector Material: Wood flour	Two incidents. One for reasons unknown and one as result of piece of metal going through one of the grinding stones and causing fire
Les Raffineries de Soufre Reunies Grinder and bag filter Material: Sulphur	Two incidents. Reasons unknown but probably static
Plastics manufacturer Grinder and hopper Material: Cellulose acetate	Three incidents. One caused by distortion of screen causing contact of hammers on rotor. One by stones in grinder and one by ferrous metal in grinder
A. & R. Scott Ltd. Grinder and cyclone collector Material: Oat husk	Two incidents. One foreign metal in grinder. One seizure of grinder rotor
Tate & Lyle Ltd. Grinder Material: Icing sugar	One incident. Mesh in grinder caught in flails
Wood Flour Millers Ltd. Grinder and cyclone collector Material: Wood flour	Three incidents. Two unknown reasons and one foreign body in grinder

Application

Whilst these methods were originally developed for the more severe gaseous or fuel/air mixture type of explosion, the majority of applications have so far been in the dust explosion field. Any material which will burn in the bulk—even materials which will not readily ignite, such as chewing gum—can explode if in a sufficiently finely divided state.

Typical of the industries in which these methods find increasing application are:

Food: Cocoa, gravy powder, cereals, soya flour.
Plastics: Many finely divided materials, including synthetic resins and cellulose acetate.
Chemical: Chemicals, pharmaceuticals and solvents.
Fertilisers and insecticides: Many finely ground materials.
Animal feeding stuffs: Fishmeal and other cattle-cake ingredients.
Margarine: Disintegration of groundnuts and coconuts.
Linoleum: Wood flour, cork and coconut shells.
Paint and dyestuffs: Colours and pigments.
Printing: Solvent risks.
Petroleum and petroleum products: Gases and vapours.
Pulverised fuel: Coal and peat.

Suppression cannot normally be applied to metal dust explosion risks because the temperature of combustion is so high that the suppressant would be decomposed. Also suppression is not applicable to materials which provide their own oxygen for combustion. However, the other techniques described can be applied to these types of risk.

Four different methods have been developed to apply to industrial explosion hazards:

(1) Explosion suppression.
(2) Explosion venting.

(3) Isolation.
(4) Advance inerting.

These methods, which are sometimes used singly but more often in combination, are outlined below.

Explosion suppression

A suppression system is operated by detecting the explosion very early in its pressure growth by the use of a rate-of-rise of pressure detector and a suppressor which extinguishes the explosion flame before the pressure has time to rise to dangerous values. Fig. 1 illustrates the sequence of events in the suppression of an explosion in a typical 1,000-gal. tank.

The suppressor usually takes the form of a hemisphere which is burst open when the explosion is detected, causing the extinguishing agent to be distributed at a speed greater than 200 ft./sec. throughout the volume in which the explosion flame is developing.

Explosion venting

The venting technique used involves the explosive actuation of a device to relieve the explosion pressure. One of these can be burst at pressures as low as 0.1 p.s.i. Such a bursting disc is thus virtually the equivalent of an 'open' vent and, consequently, less vent area is required than is the case with conventional bursting discs. Although the *Armourplate* glass bursting disc can be operated at such low pressures it is very strong and able to withstand large variations in normal operating pressure or alternate vacuum and pressure, and its bursting pressure can be controlled very accurately—to within $\pm 2\%$ if necessary. Thus it also finds application in the chemical industry for venting the 'run-away reaction' type of explosion.

Whatever type of bursting disc is employed—and there is no point in using an *Armourplate* glass bursting disc if a paper or simple flap type of vent can be used—a suitable extinguishing agent is usually triggered simultaneously to extinguish the residual fire.

Fig. 2 illustrates the explosion-detector-operated vent technique.

Advance inerting

One of the great dangers of explosions is that flame may propagate through ducting from vessel to vessel causing extensive damage. By introducing an inerting concentration into those sections of the plant away from the seat of the explosion, the further propagation of the explosion is prevented. This technique is illustrated schematically in Fig. 3.

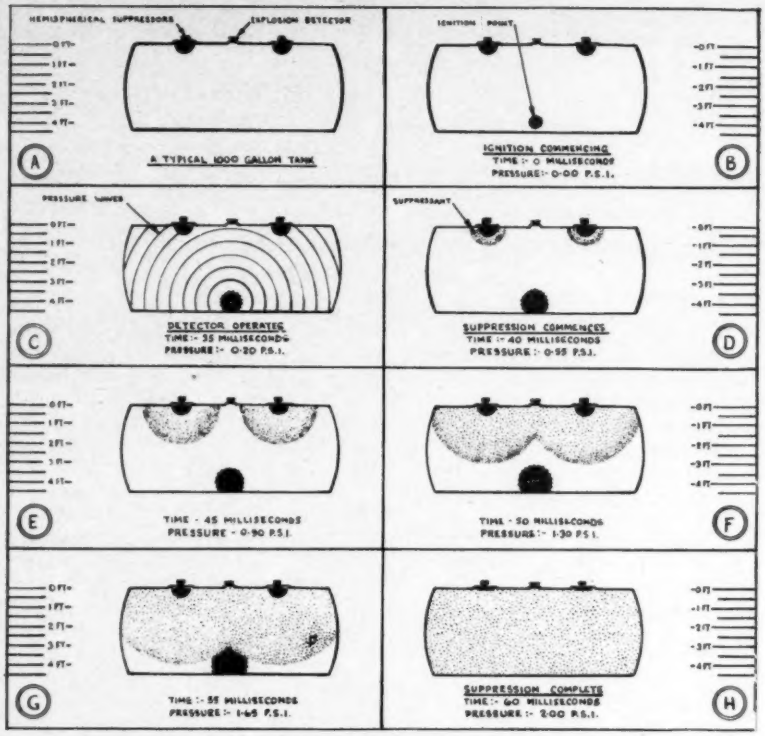

Fig. 1. Suppression of an explosion in a 1,000-gal. tank. Flame speed, 15 ft./sec.; pressure wave, 1,000 ft./sec.; suppressant speed, 200 ft./sec.

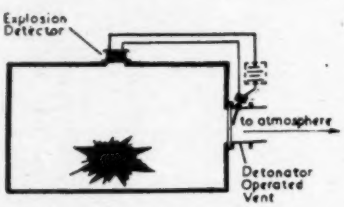

Fig. 2. Detector-operated vent technique.

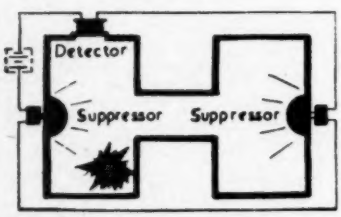

Fig. 3. Advance inerting technique.

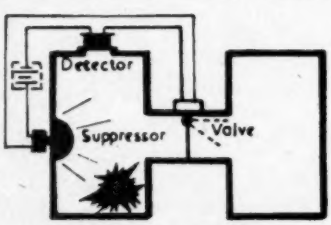

Fig. 4. High-speed isolation.

It is important to note that, although a vessel itself may be protected from explosion damage by suppression or venting, it is still possible for flame from this vessel to propagate elsewhere. It may be asked: why should there be any danger of flame escaping down a duct from a vessel which is suppressed? It can be seen that this is possible when it is realised that if the ignition happens to be near an outlet, although the explosion flame would be prevented from spreading within the vessel, some flame might escape to do damage elsewhere.

Isolation

High-speed isolation is an alternative method to advance inerting for the prevention of explosion flame propagation throughout a system. Valves of the flap or butterfly type are used and a typical 8-in. flap valve as illustrated in Fig. 4 will close in about 80 milliseconds. A suppressor is usually incorporated after the valve to extinguish any flame which might pass through while the valve is closing. Such a combination for an 8-in.-diam. duct would give isolation in about 5 msec., which is the distribution time of the suppressor.

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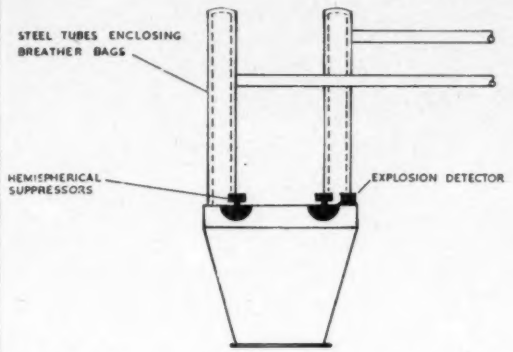
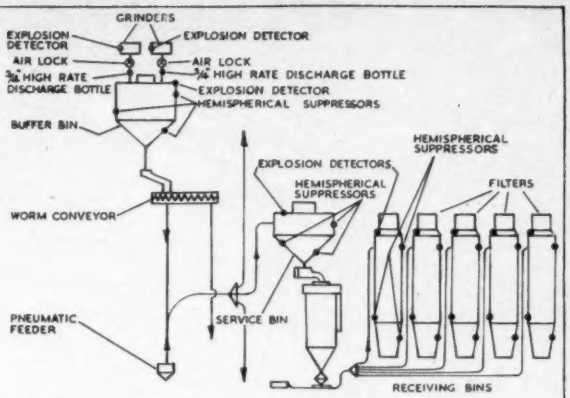
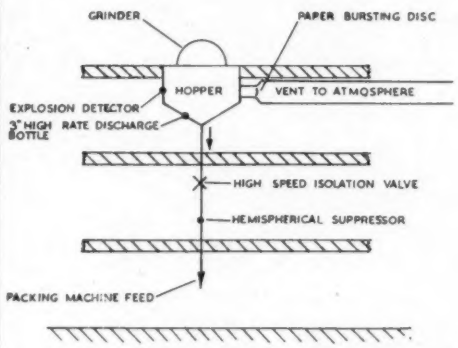


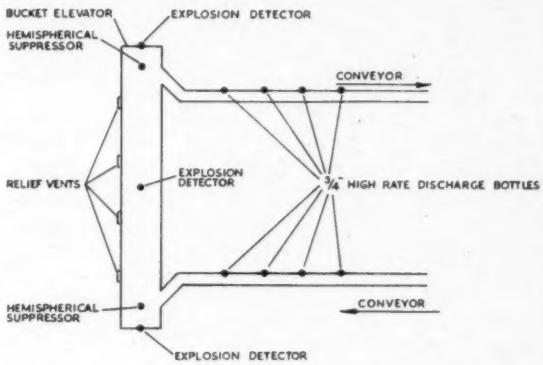
A. ICING SUGAR GRINDING AND COLLECTION:- The Grinder is suppressed and the Breather Bags enclosed in steel tubes vented to the outside atmosphere.



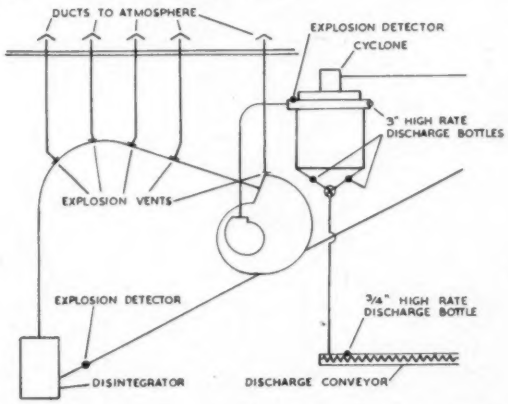
B. PNEUMATIC HANDLING PLANT FOR FLOUR AND SUGAR:- A suppression system divided into a number of sections each of which is an independent explosion risk ie., (a) The Grinders, (b) Buffer Bin, (c) Service Bin and (d) Receiving Bins.



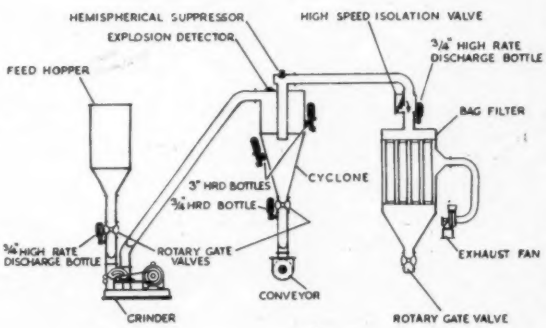
C. ICING SUGAR GRINDING AND COLLECTION:- Grinder Hopper vented to outside atmosphere. Fire extinguished by High Rate Discharge Bottle. High Speed Isolation Valve and the Suppressor prevents flame or burning material entering packing machine.



D. BUCKET ELEVATOR SYSTEM HANDLING GRAIN OR CEREALS:- Explosion in Elevator relieved by Flap type Vents direct to atmosphere. Flame propogation along conveyors prevented by advance inerting.



E. RING DRIER HANDLING STARCH:- Ring Drier and Manifold vented via ducting to atmosphere. Cyclone is suppressed and Discharge Conveyor inerted



F. EXPLOSION PROTECTION FOR A TYPICAL GRINDING PLANT:- Grinder and Cyclone suppressed. Discharge Conveyor inerted. High Speed Isolation Valve and the High Rate Discharge Bottle prevents flame or burning material entering the Bag Filter.

Fig. 5. Examples of how the explosion protection techniques described in the article are applied to various types of industrial plants.

CENTRIFUGING

By E. Broadwell

New high-speed and low-speed centrifuges for industry; laboratory centrifuges; new centrifuge applications in the sugar, oils and fats, chemical, food, dairy and petroleum industries

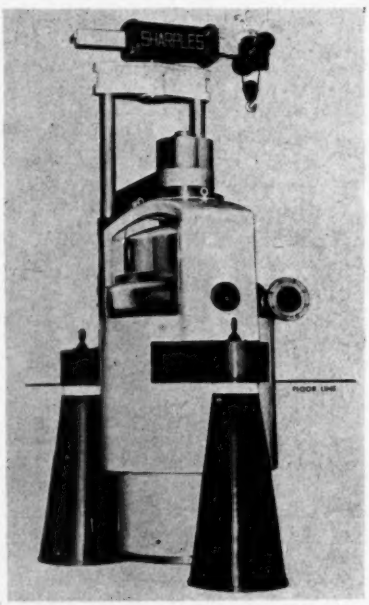
THE most noteworthy events covered by the period under review have been the announcements of new machines by centrifuge manufacturers. For the most part they consist of larger versions of existing machines whose characteristics have been thoroughly evaluated in commercial operation. This is a logical and natural development and it is satisfying to note that new design work, modern materials of construction and production methods are able to keep pace with the increasing demands for these very large machines. For other developments in this field, however, the situation cannot be considered at all satisfactory and a search was made in vain to find any recently published fundamental studies, or even general information, which would materially assist in an understanding of the subject.

Flood[1] has published a review which covers the developments in the U.S.A. There are a number of references to ultra-centrifugation which are not covered in the text, and the majority of the other references have been included in previous reviews in CHEMICAL & PROCESS ENGINEERING. In an exercise[2] to determine whether pilot-plant studies of the various sections of a hypothetical process are necessary, some interesting questions are posed. These concern the application and type of centrifuge being considered for the separation of the catalyst used in the process. In the scheme an existing machine is available and suggestions are made for arriving at the optimum solution with the minimum effort. Not all centrifuging problems resolve themselves as readily as the case quoted, but the method of approach is fundamentally sound.

Many present-day developments in this field are accepted at their face value, but the application of high-speed centrifuges to industrial problems stems from their initial use as cream separators. The pioneer work in this direction was carried out by Dr. Gustaf de Laval, and 1958 saw the 75th anniversary of the group of companies formed to develop these applications.[3, 4] It is interesting to compare the initial design of centrifuge bowl having a capacity of a few gallons per hour with the modern machines capable of dealing with feed rates in excess of 20,000 gal./hr. This aspect is dealt with further[5] in a survey of progress in chemical engineering equipment.

New industrial machines and developments

Reports covering the Chemical and Petroleum Engineering Exhibition, Achema XII, and the 26th Exposition of Chemical Industries provide a useful guide for assessing the latest trends and availability of different types of centrifuges. Several of the new machines were displayed by international companies at more than one exhibition. First introduced in the U.S.A. is the Sharples P7000 *Super-D-Canter*,[6–12] a vertical, solid-bowl machine with conveyor for the continuous discharge of up to 12 tons/hr. of solids. It can handle feed rates of up to 15,000 gal./hr., has a bowl diameter of 29 in. and a length of 59 in., rotating at 2,000 r.p.m., and develops a maximum centrifugal force of 1,640 times gravity. Three models are available for different operating pressures up to a maximum of 150 p.s.i. In addition, there is a smaller size of the same vertical pattern, type P4000, designed for operating at capacities up to 2,400 gal./hr.[8, 9, 11] One of the interesting mechanical features of these machines is the vertical arrangement of the bowl which becomes self-centring and allows the gearbox to be made integral with the bowl. Also, from the same company, is the type P3000,[6, 7] which is similar to the older horizontal *Super-D-Canters* but provided with a longer bowl with a rotational speed of 4,000 r.p.m. These new additions to the Sharples range of machines of this type now provide an excellent coverage for all the capacity and speed requirements of problems in which their use is envisaged. The Sharples DH-6 *Nozljector* is another new, high-capacity machine of the nozzle type;[6–8] it is provided with a 30-in. diameter bowl rotating at 3,000 r.p.m. and is variously described as being capable of operating at capacities up to 18,000 and 24,000 gal./hr., and pressures up to 50 and 150 p.s.i. It can be provided with or without a recirculating system to obtain maximum concentration of solids in the nozzle discharge and can be fitted with a motor size up to 125 h.p. depending upon the duty. The range of Sharples *Super-D-Hydrator* basket machines[13] have been described previously in these reviews, but some



The Sharples P 7000 vertical 'Super-D-Canter' shown here introduces a new concept in the design of scroll-type centrifuges.

new features have been introduced to improve performance and efficiency.[14]

The automatic, intermittent, solid-discharging type of separator is gaining favour for many industrial applications where the use of normal manual cleaning or nozzle types of centrifuges would be uneconomic. The latest additions to the De Laval range of such machines include the HMPX309-00S, FRPX309-10S and the AFPX 309-10B.[15] These machines are based on the earlier model PX309-30S and are designed respectively for the treatment of liquids having a higher-than-normal specific gravity, the separation of oil from, and clarification of, fruit juices, and the purification of animal fat. Two new sizes of machines are also announced, one being a smaller machine, type PX207-00S,[16–18] suitable for lower throughputs on any problems where this class of machine is used; it has a relative efficiency of approximately half that of the PX309-30S. The other new machine, type PX213-30,[15] is described as being twice as efficient as the PX309-30S size, with a sludge-holding capacity of up to 25 litres. It can be arranged for paring disc discharge or, alternatively, be of all hermetic construction. It is particularly intended for duties in breweries and for problems where high rates of flow of liquor are required.

There is an increasing demand for machines required to operate in processes under pressure, and another new series of De Laval machines designed for this type of duty is based on the type B214-00.[15] The basic machine is of the disc type in which the solids are held in the bowl and cleaned manually or by back flushing. It is of very high efficiency and can be arranged for pressure discharge by paring disc, with or without gas-tight execution or, alternatively, be of totally hermetic design with special safety seals. These machines can also be designed for either liquid/solid or liquid/liquid/solid types of separation and have a solid holding capacity of 25 l. Typical applications for such machines include the separation of small amounts of catalysts from highly inflammable solvents, solvent/broth separations in antibiotic extraction processes, and the separation of water from jet-engine fuels for aircraft. This new range of large machines will undoubtedly offer solutions to problems for which, previously, there was no satisfactory or economic solution.

A new, large, sludge space clarifier is also announced by the same company.[15] This type of machine is intended for duties where the solid content of a liquid is relatively high and not suitable for treatment by intermittent or continuous solid discharging machines. Designated the L314-30 it contains five cylinders in the bowl which can accommodate 70 l. of sludge, and its efficiency is twice that of previous models of this type. Like so many machines today, it is available with pressure discharge or of totally hermetic construction. Other new developments from this company include a high-efficiency, pressure-sealed, recirculating-type nozzle machine QX312-30SE for solid/liquid separation, two additional open-type, high-capacity recirculating nozzle machines for liquid/liquid/solid separation, and a larger desludger type NX214-31B which has a horizontal, combined cylindrical and conical bowl, with conveyor for transport of solids. Reports from various exhibitions[19–21] include details of De Laval machines already covered in these reviews.

There are additional reports from exhibitions dealing with lower-speed machines. A Podbielniak contactor[22] capable of dealing with up to 90,000 gal./hr. of feed material is claimed to be the largest-capacity centrifuge in the world. These are tailor-made specialised machines intended for washing, solvent extraction and similar duties where solid contents of the liquor are very small. A 54-in. variable speed, ploughing, basket machine arranged for bottom discharge is announced by Broadbent.[23, 24] From the Achema[25] some brief details are given of continuous conveyor and push-type centrifuges.

A new, rubber-lined, horizontal, continuous filtering centrifugal is announced by Baker Perkins;[26] this machine is capable of taking a 20.5-cu.ft. charge and is of variable-speed design between 125 and 640 r.p.m. An improved version of a continuous conical slotted-screen centrifugal for dewatering 50 to 80 tons/hr. of solids is also available.[27]

Laboratory machines

There is an increasing tendency to undertake small-scale and pilot-plant centrifuge experiments as a forerunner to many industrial processes, and centrifuge manufacturers usually offer excellent facilities for carrying out such work and are able to correlate the results to commercial machines. Unless proper interpretation is made of the data so obtained, however, it is very easy to miss the selection of the most appropriate type of machine for the required duty. It is also of importance in these circumstances to utilise a small machine having a relative bowl residence time and corresponding centrifugal force to a commercially available unit. A three-speed Broadbent basket-type machine fitted with plough and arranged with bottom discharge is in this category.[28]

Other new machines for general laboratory work where continuous

Spinnlied

Of Force Centrifugal shall be my song—
A theme which poets have been strangely mute on.
(Doctor Bronowski has remarked how strong
Was Blake's antipathy to Isaac Newton.)
Yet this unhonoured, unassuming Force
Our human lot most bounteously enriches,
Steering the planets in their stately course
And hurling cornering road-hogs into ditches.
Long has it served our race in separating
Cream from the milk and honey from the comb,
And, at this moment, is initiating
A minor revolution in my home,
Where my pyjamas, to its sway subjected,
Come from the wash with buttons unbisected.

E. V. MILNER

(Reprinted by permission of 'PUNCH')

operation is required include the MSE models 300 and 3000.[29] Both machines can be supplied with perforated or unperforated baskets constructed from aluminium or stainless steel, and stepless speed variation up to 4,000 r.p.m. The 300 model has a 5-in. basket with a cake capacity of 300 c.c., and the 3000 model has a 9½-in. basket and capacity of 3 litres. A report from Achema[30] gives further details of the angle head and refrigerated centrifuges available from this source.

A De Laval hermetic, laboratory, disc-type separator, BRH205-30H,[15] is now available. Primarily designed for experimental work in connection with brewing, this machine possesses all the salient features of the large commercial machines used extensively in this industry. It can, however, be utilised where any hermetic conditions are required and it is designed to work under pressure at capacities up to 30 gal./hr. Another new De Laval laboratory separator is the type LAB201-20. It is suitable for liquid/solid and liquid/liquid/solid separations and is available in open or gas-tight execution with all contact parts of stainless steel. The bowl has a solid holding capacity of 64 c.c. and rotates at 15,000 r.p.m. It is understood[15] that this machine is intended for general laboratory work and does not replace the current type 1229 machine which is designed for pilot plant and scale-up operations. For small-scale yeast separations, there is also a continuously operating De Laval type YEB1330 machine.

A combined basket and tube-type centrifuge, and a refrigerated, variable high-speed tube centrifuge are among some further developments reported.[28] A description of a two-piece centrifuge tube for handling micro-quantities of precipitates will be of interest to operators in this field.[31]

Sugar

The factors affecting the purging characteristics of a low-product massecuite in centrifugals are discussed by Phipps.[32] These are considered to be viscosity, crystal size and centrifugal force, in this order of importance, and are considered in some detail. The view is expressed that high centrifugal force alone will not compensate for an unsatisfactory massecuite condition. Some test runs using a Mercone continuous centrifugal with massecuite in Hawaii are reported.[33] The machine operated at 4 tons/hr., but the grain was still crushed despite attempts to prevent it; this defect is thought to be due to impact on discharge and further modifications are planned. The results of tests with the Russian PN1000 high-speed centrifugal have been described; the account[34] also includes the details and characteristics of the machine. Brief details of a process for treating blackstrap molasses with lime and phosphoric acid followed by centrifuging are given in a further report.[35] Sugar quality is improved by washing with superheated water in a centrifugal.[36] Details of the 12 centrifugals to be installed in the new Ceylon factory are reported.[37] Patented processes involving centrifuging include the treatment of B-molasses to improve quality and yield of C-sugar,[38] and the clarification of juice after electrolysis and *p*H adjustment to bring down material rendered insoluble.[39]

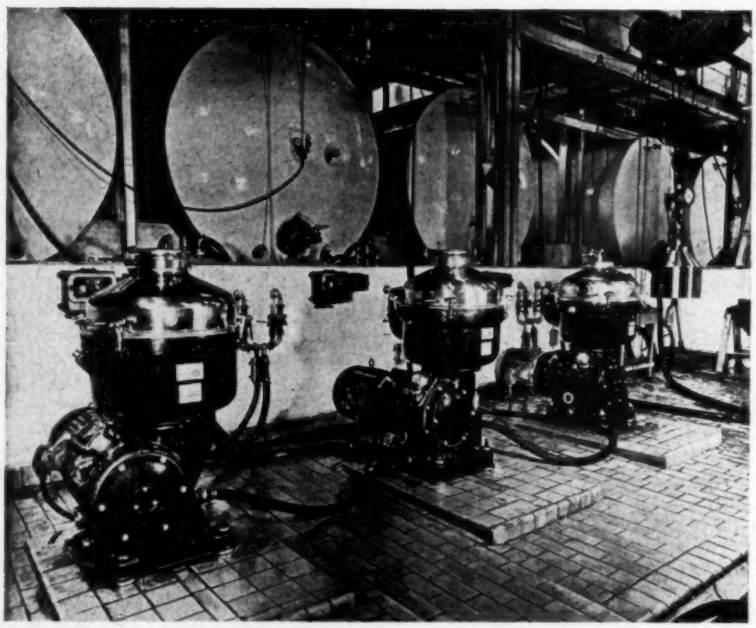
Reports covering the operation of multi-stage push-type centrifugals in this industry continue to appear. One Russian investigation[40] covers comparative trials between this type and self-discharging machines, whilst another[41] gives results on first- and second-product massecuite. South African experience using an Escher Wyss type C4/4 on white and raw massecuites is covered in a further report.[42] Developments and the latest modifications to this type of machine are given in a report by Ruegg.[43] A four-stage model used in two German white-sugar factories operated satisfactorily at a capacity of 6 to 7 tons/hr. with a power requirement of 2 kw./ton.[44]

Results from more orthodox and high-speed machines are covered in a further Soviet report[45] and modifications to the filling device of a second-product centrifugal are described.[46] Results with a pneumatically operated feeding device for a white sugar centrifugal are reported.[47] A plea is made for the standardisation of centrifugals and baskets to permit interchangeability.[48] Oscillograms for various centrifugals under different load and speed conditions provide a useful means for overcoming vibrations caused by out-of-balance and other external factors.[49]

Numerous patents for machines and auxiliaries in this field continue to appear: push-type,[50–54] continuous[55–58] and automatic[59] machines; charging devices,[60, 61] interlocking and safety devices,[62–64] washing arrangement,[65] discharging mechanisms,[66–69] driving arrangements,[70, 71] a strip lining for a basket[72] and an automatic control system for a complete battery of machines.[73] Drives for centrifugals are dealt with in three reports.[74–76]

Oils, fats and soaps

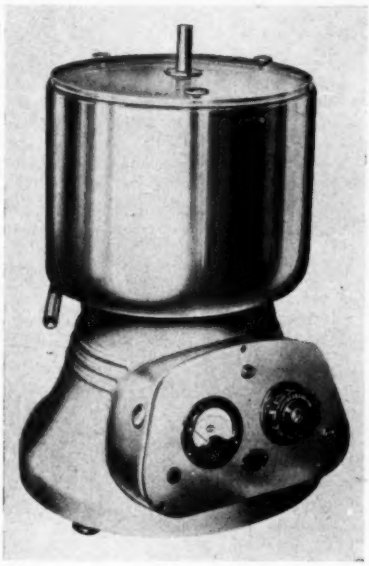
There is a large potential application for centrifuges in oil-extraction processes, but the majority of new centrifuge developments in this field are covered by patents. These include



A battery of De Laval hermetic centrifuges, type BRH 214-34H, used for the clarification under pressure of 'Babycham' without loss of carbon dioxide, at the factory of Showerings Ltd., Shepton Mallet.

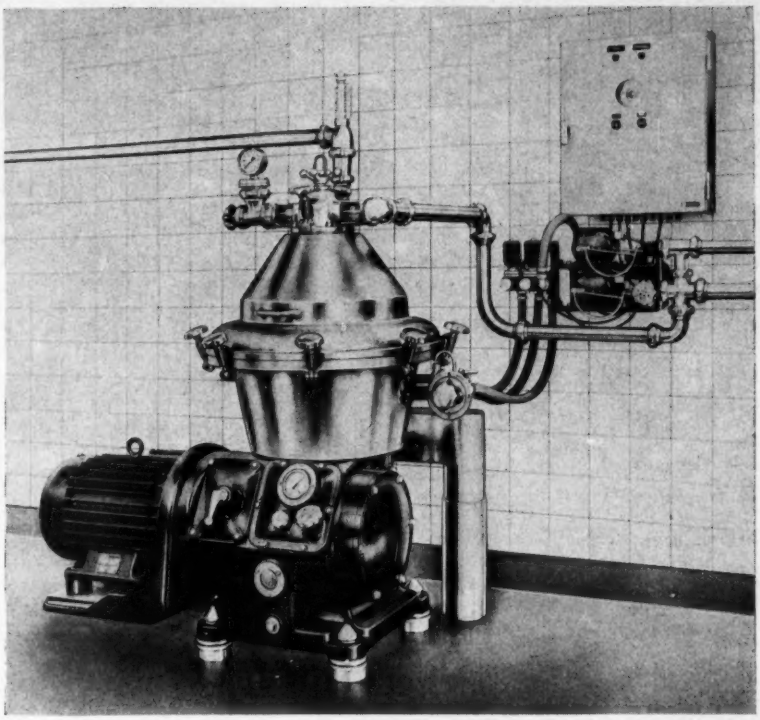
processes for an alkali digestion of the seed,[77] soap digestion[78] and emulsification using special emulsifying agents.[79] Centrifugal recovery of olive oil is assisted by the application of ultrasonic waves[80] and a specially designed machine.[81] Miscella is centrifugally separated from meal[82] and a specially designed machine is intended to handle material of paste consistency in oil milling duties.[83] A short report covers an alkali digestion process for the extraction of oil from groundnuts using low- and high-speed centrifuges to separate and break the resulting emulsion.[84]

Two articles by Braae[85, 86] give further details of investigations into the continuous refining of vegetable oils using centrifugal separators. The first report deals with water-washing aspects of neutralised oils, from which it is concluded that, when separating



One of the range of MSE laboratory basket-type centrifuges.

wash water centrifugally, more than one washing step is justified only if the mixing or separation in the first step is incomplete. The second paper covers recent progress in continuous refining using the De Laval short-mix method. The background to the various developments is given, together with some interesting data on refining losses due to various causes for different lye strengths and contact times. The effect on oil quality is compared between batch and a fully hermetic continuous system, from which it is shown that the latter system prevents deterioration of the oil by oxidation. Some further data covering the effects



An automatic timing device eliminates the need for supervision of this De Laval intermittent solid discharging type of centrifuge.

and economics of continuously degumming crude cotton-seed oil using hermetic centrifuges are given in another report.[87]

Patented processes involving centrifuges in this field cover aqueous ammonia neutralisation,[88] miscella refining with caustic soda solution followed by homogenisation and separation,[89] a method for the separation of solid triglycerides from winterised oil,[90] recovery of fatty acids from the acid splitting of soapstocks,[91] tall oil recovery,[92] and fatty acid separation in the presence of a surface-active agent.[93] A further patent describes a turbulence chamber fitted to a centrifuge designed to give lower refining losses.[94]

A new, self-contained fishmeal plant, employing a gas turbine, is provided with a centrifuge for recovering oil when processing oily fish.[95] The machine is driven by line shaft drive from the gas turbine. Brief reference is made to a Titan *Super Ejector* for recovering oil from cooked, disintegrated shark's liver.[96] Patents cover processes for improving herring oil yields by evaporation before centrifuging,[97] a similar process employing a preliminary centrifuging step prior to evaporation[98] and the separation of fatty alcohols in the presence of an electrolyte or surface-active agent.[99]

Patents, only, cover progress in centrifuge applications in the fat processing industry. Two[100] cover the treatment of slaughterhouse drainings and animal fat rendering, respectively, both processes employing a double centrifuging treatment; a further process is arranged to recover fat and degreased material for the production of glue and gelatine,[101] and a system for the production of ground bone.[102]

In the soap field further references have been made to the De Laval *Centripure* continuous process using hermetic centrifuges[103, 104] and Podbielniak machines.[105] Allied to this field is the centrifugal recovery of salt from glycerine lyes arising from the saponification process.[106] A patented process covers the use of a slow-speed basket machine for the separation of soap and nigre.[107]

Chemicals

One of the most interesting reports in this field[108] concerns the use of specially designed, tubular-type centrifuges for the enrichment of gaseous uranium isotopes. The centrifuge process was tried some years ago, but was abandoned in favour of the current diffusion method of separation. The present work has developed steadily

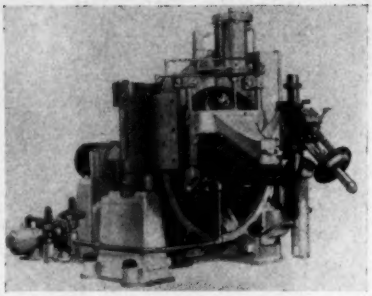
from the initial study using two machines with bowls 7.2 in. diam. and 25 in. long. Eight new machines with bowl lengths of 47 in. are to be tested and a further type is projected with a bowl length of 118 in. These machines rotate at 32,000 r.p.m. and develop a centrifugal force of 100,000 times gravity. It has been ascertained that the bowl length, in relation to the diameter, which has been kept constant, controls the degree of enrichment obtained. Despite the size and speed of the units, it is claimed that the power costs will only be about one-tenth of the diffusion process. Also referring to uranium extraction are two reports[109, 110] describing the use of Podbielniak machines, the first relating to its recovery from a leached concentrate obtained by the froth flotation of a complex ore.

In an investigation into the production of calcium - 2 - ketogluconate[111] tubular and perforated basket centrifuges are used for clarifying the liquors and crystal recovery, respectively. Some yield comparisons between filtration and centrifugation are quoted. In the refining of crude aureomycin[112] the crystals are recovered and washed in a centrifuge.

Two new continuous processes for the production of nitroglycerine use centrifuges for the separation of the nitrated product from the spent acid. The first process[113, 114] was developed in Sweden and employs a specially designed De Laval centrifuge; the second process[114, 115] also uses a special type of centrifuge. Reference is also made[114] to the possibilities of separating nitroglycerine/water mixtures by centrifuge after they have been pumped through pipelines. Other duties of centrifuges in the chemical field include sodium formate separation in the production of pentaerythritol,[116] potassium borohydride recovery[117] and hexamine separation.[118]

Miscellaneous applications

Some further data covering the effects of recycling centrifugally recovered yeast in fermentation processes are reported.[119] A tubular and disc type nozzle centrifuge has been used for harvesting micro-organisms at very low throughput rates; some results from the two types of machines are given.[120] Large sludge space centrifuges each operating at a capacity of 50 bbl./hr. are used for the clarification of hot wort.[121] The description and operation of centrifuges for beer clarification is reviewed, and their advantages over filtration economically justifies them replacing filters.[122]



The C-4l Sharples 'Super-D-Hydrator' has many new features incorporated as a result of a close study of the requirements of chemical industry.

A brief description of the De Laval separators used for washing starch free from gluten is included in an article covering the production of maize starch.[123] Three separate centrifuging operations are used in a process for the production of promaline from maize gluten.[124] In the dairy industry, three patents respectively cover the use of centrifuges for speeding up the manufacturing process for cheese[125] and the separation and treatment of cream for the production of sterilised butter.[126, 127] Passing reference is made to the centrifugal process of concentrating rubber latex,[128, 129] centrifuges suitable for the clarification of writing ink, ball-point pen and printers' inks,[130] and patents for centrifuging grease from processed froth derived from wool scouring liquors.[131, 132]

In the petroleum industry, reports continue to appear[133–135] concerning the centrifugal process for the recovery of oil from the Athabasca tar-sands, but full details of the design of the centrifuge have not yet appeared. A further article[136] describes the use of centrifuges for removing unwanted solids from drilling muds. A useful report[137] gives a brief summary of investigations into the centrifugal treatment of detergent lubricating oils together with recommendations for achieving optimum results. Details of new De Laval centrifugal equipment suitable for the treatment of turbine lubricating oils are released;[138] an interesting feature is the use of a plate-type heat exchanger with regenerative section for heating the oil prior to centrifuging.

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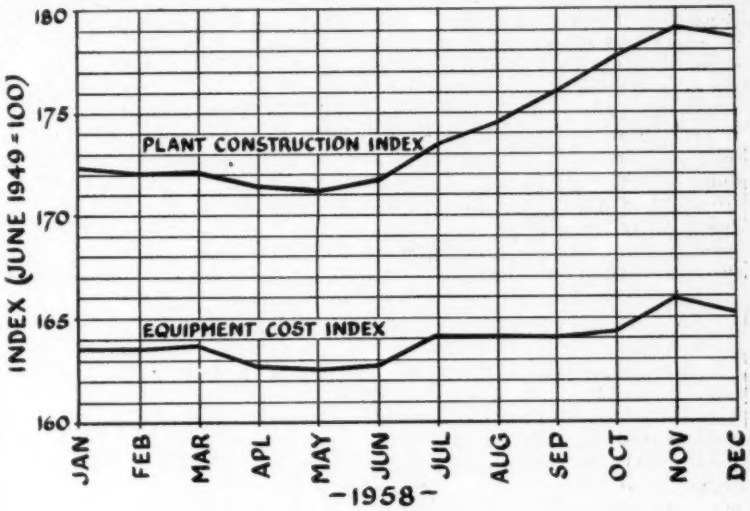
Chemical Plant Costs, 1958

A feature of industrial economy in 1958 has been the recession in America coupled with a decline in import prices of non-ferrous metals. The Marshall and Stevens index for U.S. equipment costs (published in *Chemical Engineering*) shows a much greater dip in the middle of the year than does our own. The U.S. index dropped 5% in the second quarter of the year but the U.K. index dropped only 1½% at the same time.

It may be that our own industry could have passed on to its customers a greater share in the benefit derived from lower import prices. However, we have had, over the year, a negligible increase and that in itself is a distinct benefit.

Internal prices for steel and other constructional materials have shown little or no change; only usages have risen in the latter part of the year. These facts are shown by the profile of the Construction Cost Index which is steady for the first half of the year and rises only after mid-year. This index shows an overall rise of 3½% which is the lowest since 1953 when there was no rise at all. Since then the average annual increase has been a little under 5%.



CPE Chemical Plant Cost Indices, 1958

(Indices in both cases are based on June 1949 = 100)

Monthly Indices, 1958

	Construction Cost Index	*Equipment Cost Index*
January	172.3	163.5
February	172.0	163.5
March	172.0	163.6
April	171.3	162.7
May	171.1	162.6
June	171.7	162.7
July	173.5	164.1
August	174.5	164.1
September	176.0	164.0
October	177.7	164.3
November	179.0	165.9
December	178.5	165.2

Annual Averages, 1948-58

	Construction Cost Index	*Equipment Cost Index*
1948	98.3	95.2
1949	101.2	99.7
1950	110.6	109.5
1951	129.5	116.4
1952	141.9	127.9
1953	139.4	130.0
1954	143.6	135.0
1955	157.4	143.3
1956	165.8	153.2
1957	170.9	161.3
1958	174.1	163.9

Cost Indices for January 1958:

Plant Construction ... ... 178.5 Equipment Cost 165.2

Melting Out Fats in Drums

Novel installation at Belgian lanolin factory

The problem of melting out solid fats from drums before processing is encountered in a number of industries, among them the lanolin manufacturing industry in which the raw material, wool grease, is particularly difficult to extract from the drums. The new factory of Croda Belge S.A. at Verviers, Belgium, uses a novel melting-out plant arranged as follows.

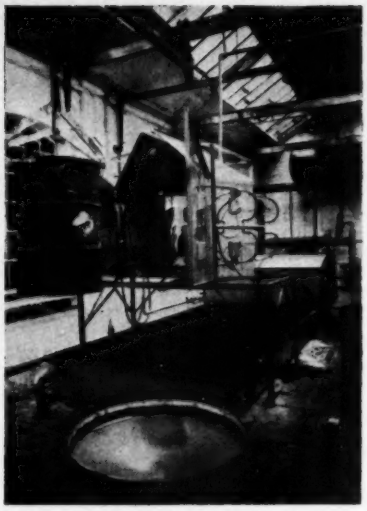
There are two main parts to the plant, the first being a heating chamber consisting of an aluminium box, with two infra-red heating elements on each of the six sides facing inwards, and an open bottom. This is mounted above a steel bath heated by a hot-water jacket, the jacket being fed with waste hot water from various processing units in the main plant.

The operation can be carried out by one man and involves first removing the head of the drum of wool grease and inverting the drum under the drum lifting device. The drum is then lifted and by means of the small crane is moved into the heating chamber. The doors are automatically closed on the drum and the 12 infra-red elements focus on it.

After about 4 min. the outer surface of the wool grease has melted sufficiently to enable the bulk of the material to slip gently from the drum into the bath. The operation is repeated until the complete batch of wool grease, consisting of, say, 12 drums, has been emptied into the bath and completely melted, when it is pumped away to the main processing plant.

This novel system has proved an effective answer to the melting-out problem and obviates all the former disadvantages of melting out wool grease except when the grease comes packed in drums without removable heads, *i.e.* in lubricating oil-type drums. These always present difficulties when used for wool grease and the only solution so far found in Belgium is to cut off the head completely, which is quick but somewhat expensive.

Croda Belge was formed early in 1958 by Croda Ltd., England, in conjunction with five leading companies of the Belgian wool industry. The new plant is claimed to be the most modern lanolin plant in the world and is initially planned to be large enough to supply all the lanolin requirements of the Benelux countries.



Inside the Croda Belge lanolin factory: a drum of wool grease, upside down, is being moved into the heating chamber.

Explosion Protection in Industry

(*Concluded from page* 84)

These types of valves are also frequently used for retaining suppressant in systems which might otherwise be swept out by air flow.

The time available for isolation depends on the type of explosion expected, the position of the valve relative to the source of ignition, the normal velocity of the dust or gas flow along the ducting and the direction of the normal flow. The most difficult combination of conditions to design for is the case of the slow explosion where the normal velocity in the ducting is high and the valve is required to be upstream of the normal direction of flow. In such a case, since with a slow explosion, flame might escape from the vessel before the explosion pressure reaches a value high enough to trigger the pressure detector, photo-electric methods of detection may be used.

Automatic plant shutdown

Whatever method of protection is employed it is desirable for the plant to be shut down automatically immediately an explosion occurs, for the following reasons:

(1) If the plant is simply vented and rotary gate valves are employed, it is important that these should stop rotating immediately to prevent smouldering material passing to the ' isolated ' part of the plant.
(2) If feeds continue, the fire within the plant will be more serious and product will be wasted.
(3) Immediate shutdown makes it easier to discover the causes of the explosion and may prevent further damage to the plant.

To Authors

The Editor welcomes practical articles and notes on chemical engineering and related subjects with a view to publication. A preliminary synopsis outlining the subject should be sent to The Editor, CHEMICAL & PROCESS ENGINEERING, Leonard Hill House, Eden Street, London, N.W.1.

In the author's experience of some 35 dust explosions, careful investigation after automatic plant shutdown has revealed the cause of the explosion and enabled corrective measures to be applied in 23 cases.

Automatic plant shutdown is provided by the electrical power unit which provides the current for operating the system. A battery standby is incorporated to take care of mains supply failure and all circuits are continuously monitored to give warning of any electrical fault. Electrical interlocking also ensures that the plant cannot be operated unless the protection system is in operation.

Typical explosion protection schemes

How these techniques are applied in practice to different types of plant is illustrated in Fig. 5.

New plant design

Although these methods can and are being applied to existing plants, a careful study of explosion problems at an early stage in the design of a plant can often result in considerable simplification and consequent saving in capital expenditure.

FLOW METERS

In the following pages we present a special survey of this subject

New Trends in Flow Measurement

FLUID flow measurement is a field in which there have been few spectacular developments in recent years, but from the simple methods which served industry in the past have been developed an extensive variety of instruments using various principles of operation, some being primarily designed for specific duties or for integration with recorders and other control equipment, while others have a very broad range of applications, some even being indifferent to whether liquids, gases or vapours are being handled.

To the engineer whose task it is to select a flow meter for a particular process the number of possible alternatives may seem bewildering, but a study of these instruments will show that they can be divided into two or three broad groups which again can be divided into a number of subgroups, variations of the basic pattern being made to meet particular needs. In general, the choice of a meter is best made in consultation with the manufacturers of flow instruments, who will want to know the nature of the fluid to be handled, the pipeline pressure, and flow velocity and temperature of the fluid, while other factors such as the diameter and disposition of the pipeline must also be taken into account.

It is not the purpose of this special feature to attempt a summary of all the various types of flow meters available, but only to draw attention to the trend of developments in this field.

Bernouilli-type meters

The more familiar methods of fluid flow measurement make use of the Bernouilli theorem, the velocity of flow being measured in terms of the pressure changes which occur in the pipeline above and below the point of measurement. The long-established orifice-plate meter and the venturi meter continue to give service in many applications, while experiments with venturi tubes have led to the development of the *Dall* tube which is claimed to be superior to the ordinary venturi designs in a number of respects, being small, light and capable of giving better differential-pressure recovery.

Variable-area and turbine meters

Variable-area flow meters constitute another class of instruments which are useful in giving a direct reading of the quantity of fluid in motion, and they are widely used in the continuously operated processes of today. A well-known example is the *Rotameter*, which is referred to elsewhere in this issue. Another type of variable-area meter is the piston type, in which a piston or metering plug fits closely inside a sleeve and, as it is lifted by fluid pressure, it uncovers orifices in the sleeve until a sufficient area is opened to permit passage of the fluid being measured. The position of the piston or metering plug gives a direct indication of the orifice area and, therefore, of the rate of flow.[1]

The turbine type of flow meter, well established for the measurement of petrol flows, has been applied to numerous other industrial liquids; however, one recent writer[2] considers that some extravagant claims have been made for the value of this type of instrument in measuring slurries, pulsating flows, etc.

Electromagnetic and ultrasonic techniques

The increasingly complex nature of many modern manufacturing processes, and the need for simplifying maintenance problems, have led to increasing interest in such devices as the magnetic flow meter, which offers the advantages of producing a flow signal without using moving parts or pressure impulses and with no obstruction in the flow passage. Many industrial slurries and pulps are therefore particularly suited to this method of flow measurement, although for some fluids it would have to be ruled out if they did not have the requisite electrical conductivity. For the chemical industries, the magnetic flow meter has the important advantage that it is inherently corrosion-resistant in construction, while its simplicity answers the sanitary requirements of the food, dairy and brewing industries.

A brief description of the magnetic flow meter appears elsewhere in this issue; a detailed description was given by B. W. Balls and K. J. Brown at a symposium held by the Society of Instrument Technology in London recently.[3]

At the same meeting, another new type of flow meter which obviates the need for an obstruction in the fluid stream was described by R. E. Fischbacher. This is the ultrasonic flow meter, of which a number of different versions have been proposed, but which has not achieved the same stage of commercial development as the magnetic meter. Mr. Fischbacher explains that the basis of most of the devices so far proposed has been the modification of the apparent velocity of propagation of sound waves by the flow of the fluid. Thus the apparent velocity of propagation of sound waves observed between a point in a flowing fluid and a second point directly downstream will be the sum of the sound-propagation velocity in still fluid and the fluid-flow velocity. A refinement of the basic principle is the use of a differential arrangement, two pairs of transducers operating in different directions relative to the flow. In a further refinement, each pair of transducers is formed into an oscillating loop. Another method of applying ultrasonic techniques uses the deflection of a beam projected across the pipe, and for simplicity of operation and construction the beam-deflection system seems to have considerable advantages.

Other ways of using ultrasonics for the measurement of flow are undoubtedly possible, and it may be that in time the ultimate object of being able to measure moderate rates of flow within pipes by means of a flow meter which is wholly outside the pipe may be achieved. Meanwhile the ultrasonic flow meter is likely to find a place for itself in the range of flow-measuring devices where its particular advantages are complementary to those of other types.

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Variable-area Flow Meters

By R. Rutherford
(*Assistant Engineer, Fischer & Porter Ltd.*)

The variable-area flow meter is a widely used method of measuring fluid flow rates. This article explains how the variable-area meter works, the forms in which it is available, and the applications to which it can be put.

THE variable-area meter provides a simple means of determining the rate of flow of any liquid or gas. Basically, it takes the form of a tapered, precision-bore tube mounted vertically in the piping system with its greatest diameter uppermost, and inserted in this tube is an 'engineered obstruction,' or float, which is free to move vertically in response to flow changes. Under steady flow conditions, dynamic equilibrium exists between the downward gravitational forces and the upward velocity effects. Changes in the flow rate cause the float to move to a new position giving a new annular flow area and this permits a re-balance of forces. Indication of the flow rate is implemented in two ways:

(1) Where the metering tube is of transparent glass the graduated scale is marked on the surface and the metering edge of the float is viewed against the graduations.
(2) Where a metal tube is employed the float is fitted with an extension rod which connects it to an above-mounted indicator.

Principle

The variable-area meter, like the orifice meter, depends on the equation $V = CA\ (2gh)^{\frac{1}{2}}$. However, by selecting A (area) as the measured variable, which varies as the first power, the scale calibration is linear with a range of 10 to 1, whereas the orifice meter has a square root scale with a working range of about 4 to 1. The basic equation can be developed into working form for liquids to cover corrections for fluid density variations and also for temperature and pressure changes on gas service. Manufacturers publish correction factor curves or nomograms in terms of 1 gal./min. of water and Std. cu.ft./min. of air to assist the user in making these corrections and to aid in meter sizing.

Pressure drop

To obtain a linear scale it is essential that the pressure drop across the float head remains constant throughout the range of the instrument. The normal value of this pressure drop is about 10 in. w.g. but the necessary connections increase this to 15 to 20 in. w.g. Special tube and float combinations can reduce this figure to about 7 in. w.g. These low figures allow considerable economies in pump ratings or the use of header tanks.

Viscosity effect

The effects and allowable limits of viscosity variation have been the subject of extensive research with the result that variable-area flow meters are now universally used on streams of high or variable viscosity. The balance of forces mentioned previously did not include the effect of viscous forces that radically alter the coefficient C unless special float contours are employed. The stable viscosity (S.V.) float shape is analogous to a sharp-edged orifice, while the non-stable viscosity (N.S.V.) type is analogous to a flow nozzle. Given two floats, one S.V. and the other N.S.V., of the same weight and float diameter in the same tube, the S.V. float will have a higher range of viscosity immunity than the N.S.V. float, but the latter will have a larger capacity and hence a lower pressure loss for equivalent capacities. Thus, for any variable-area meter within fairly wide limits the flow capacity, viscosity immunity and pressure loss for a particular flow application can be accommodated by the selection of correct float shape and weight. Viscosity in unity ceilings vary from 8 centipoises for low flow and 50 cp. for high flow.

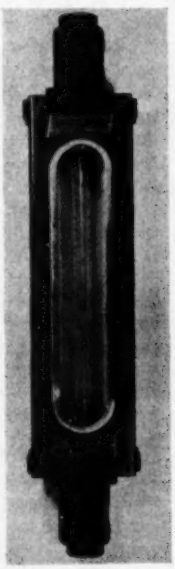
Predictability

A further result of research is that for any given application a tube and float combination can be provided giving a fully predictable performance without the need for flow testing. Such an instrument is within the accepted degree of accuracy for normal industrial use (*i.e.* $\pm 2\%$). When higher degrees of accuracy are required flow tests may be carried out. Special tubes are now available with predictable ranges as low as 0.003 gal./min.

Body types

Variable-area flow meters are available in some 16 to 20 standard body types, ranging from $4\frac{3}{4}$-in. long purge meters with plastic bodies to metal-tube meters for capacities above 6,000 Imp.gal./min. Pressure limitations vary from 15 p.s.i.g. for the rubber hose type to 5,000 p.s.i.g. for metal tube types. The most popular instrument in terms of numbers produced is the totally-enclosed 10-in. glass tube indicator with rotatable end-fittings.

High-pressure meters are of two types: one uses pressure-equalised glass metering tube with a metal body housing, while the other (Fig. 2), particularly in the capacity range above 200 Imp.gal./min., employs a flanged metal tube inserted between standard pipe tees with an overhead reading extension, and the metal tube can be



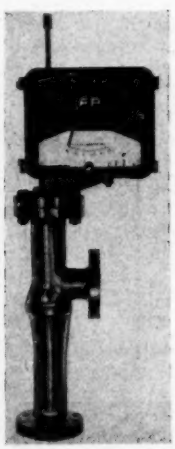


Fig. 1 (*left*). **An enclosed indicating variable-area flow meter with rotatable horizontally screwed connections and removable end-plugs.**

Fig. 2 (*above*). **An all-metal, high-capacity flow meter with an above-mounted indicating pneumatic transmitter.**

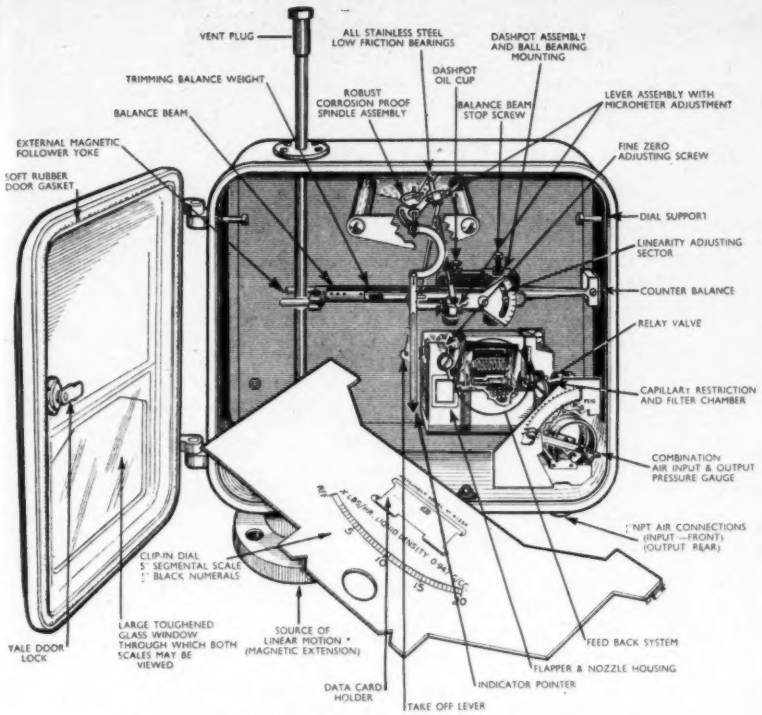

VENT PLUG
ALL STAINLESS STEEL LOW FRICTION BEARINGS
DASHPOT ASSEMBLY AND BALL BEARING MOUNTING
DASHPOT OIL CUP
TRIMMING BALANCE WEIGHT
ROBUST CORROSION PROOF SPINDLE ASSEMBLY
BALANCE BEAM STOP SCREW
LEVER ASSEMBLY WITH MICROMETER ADJUSTMENT
BALANCE BEAM
EXTERNAL MAGNETIC FOLLOWER YOKE
FINE ZERO ADJUSTING SCREW
SOFT RUBBER DOOR GASKET
DIAL SUPPORT
LINEARITY ADJUSTING SECTOR
COUNTER BALANCE
RELAY VALVE
CAPILLARY RESTRICTION AND FILTER CHAMBER
COMBINATION AIR INPUT & OUTPUT PRESSURE GAUGE
NPT AIR CONNECTIONS (INPUT—FRONT) (OUTPUT REAR)
CLIP-IN DIAL 5 SEGMENTAL SCALE BLACK NUMERALS
LARGE TOUGHENED GLASS WINDOW THROUGH WHICH BOTH SCALES MAY BE VIEWED
SOURCE OF LINEAR MOTION (MAGNETIC EXTENSION)
YALE DOOR LOCK
FEED BACK SYSTEM
FLAPPER & NOZZLE HOUSING
INDICATOR POINTER
DATA CARD HOLDER
TAKE OFF LEVER

Fig. 3. Details of an indicating pneumatic transmitter.

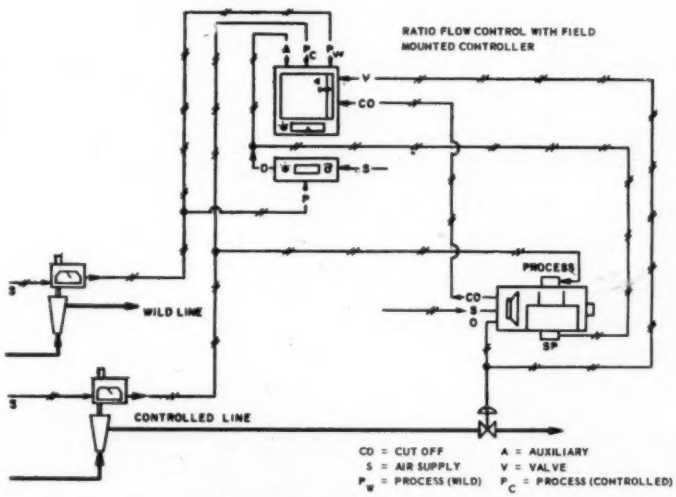


Fig. 4. Diagram of ratio flow control system.

heavy walled for extreme pressures.

In addition to 'full-flow' instruments, the variable-area meter may be used in a by-pass around an orifice plate, becoming essentially a kinetic manometer. In this instrument a small by-pass orifice regulates the by-pass flow to the main line flow and is calibrated in terms of main line Imp.gal./min. This equipment is widely used in water-treating and steam-flow applications.

Corrosion resistance is perhaps the greatest advantage of the variable-area flow meter. Body, tube and float are available in nickel, *Hastelloy*, tantalum, special bronzes, stainless steel, mild steel and cast iron. Special treatment is often given to end-fittings in the form of lead or ebonite lining.

Some body types are available as simple indicators, others incorporate transmitter and recorders.

Types of fluids

Subject to the preceding remarks covering viscosity and corrosion resistance, almost any fluid can be metered. Sediment-bearing fluids such as starch solutions, paper stock, slurries and plant waste, milk, tomato paste, mayonnaise and beer can be metered and in a glass-tube instrument any blockage affecting the movement of the float can be seen. The latest designs incorporate removable end-plugs which permit cleaning the metering tube without removing the instrument from the line.

Transmitters

There are three conventional types of transmitters: the pneumatic (using a magnetic clutch), the direct-acting impedance bridge, and the electronic servo-operated impedance bridge. Of these three types the pneumatic unit (Fig. 3) is the most popular for industrial purposes.

The float is fitted with an extension tube which houses two cylindrical permanent magnets with north-seeking poles adjacent. The float extension is completely immersed in the fluid being metered. On the outside of the extension well an additional pair of cylindrical follower magnets are mounted in a fork fashion on the balance beam assembly with their south-seeking poles adjacent to the north-seeking poles of the float extension magnets. Motion of the float is imparted in a friction-free manner to the balance beam which is mounted on a ball-bearing pivot. Even when the follower magnets are forcibly moved from their natural position, north-south attraction seeks to draw them back; thus, no matter what position the follower arm is forcibly deflected, it always returns, automatically, to its proper position as soon as the interfering force is withdrawn. In the case of a transmitter extension (Fig. 3), the position of the metering float is translated by means of the magnetic clutch through a connecting linkage to provide the input motion for a motion balance 3- to 15-p.s.i. pneumatic transmitter and indicating pointer. The air output signal from the pneumatic transmitter is proportional to the flow rate and may be used to operate a remote indicator or controller.

The performance characteristics of this unit are:

(1) Accuracy within 1% full scale.

(*Concluded on page* 101)

Instruments for Flow Measurement

A SELECTION OF NEW DESIGNS AND INNOVATIONS

Magnetic flow meter

Developed to meet the need for a fluid flow meter which will measure the volume rate of all fluids with an electrical conductivity, Foxboro-Yoxall's magnetic flow meter is particularly suited to such fluids as corrosive acids, rayon viscose, sewage, rock and acid slurries, sand and water slurries, paper pulp stock, rosin size, detergents and food products. There is no restriction of the flow line, no loss of head and no pressure taps. It is simple to install and its performance is unaffected by surrounding pipework arrangements, variations in density, turbulence, viscosity or suspended materials.

The magnetic flow meter comprises the transmitter and a *Dynalog* flow receiver which may be an indicator, a recorder or a multi-record *Dynalog*. The flow scale is uniformly linear and the meter has a rangeability of 100 to 1. The transmitter itself consists of a stainless-steel tube through which the liquid passes, an electrical insulating liner on the inside of the tube, an electro-magnet which induces a magnetic field across the tube and two metallic electrodes which are essentially flush with the inside surface of the tube. Transmitters are in line sizes varying from 2 to 8 in., suitable for flow rates from 0 to 2,500 g.p.m. to 0 to 40,000 g.p.m. The measurement of reversing flows is easily obtained and a totaliser may be included, either locally or remotely, to give flow totals in any desired units.

Computer measurement of heat flow

In a recent installation for the measurement of the heat output of a gas-cooled research reactor, the heat flow at a number of inlet and outlet ducts of the reactor is measured, the difference between the two flow values representing the heat output of the reactor. At each measuring point, a pitot tube is used as the primary flow detector, and the differential pressure so generated is measured by a flow transmitter. The output of this transmitter is an electric current directly proportional to the differential pressure applied.

The measurement so obtained represents volumetric flow in the duct, and is converted into a mass flow measurement by the use of simple analogue computers. The inputs to the computer are the signals of the flow transmitter, and of pressure and temperature transmitters which are evaluated in the computer to solve the equation:

$$\frac{h \times P}{T}$$

where h, P and T represent the signals for flow, pressure and temperature respectively.

A second computer is used to extract the square root from the output signal of the first computer, and a final signal representing the mass flow measurement is thus obtained. This signal is further processed and continuously evaluated with signals representing measured temperature and specific heat, so that a final signal representing the heat flow at the measuring point is established.

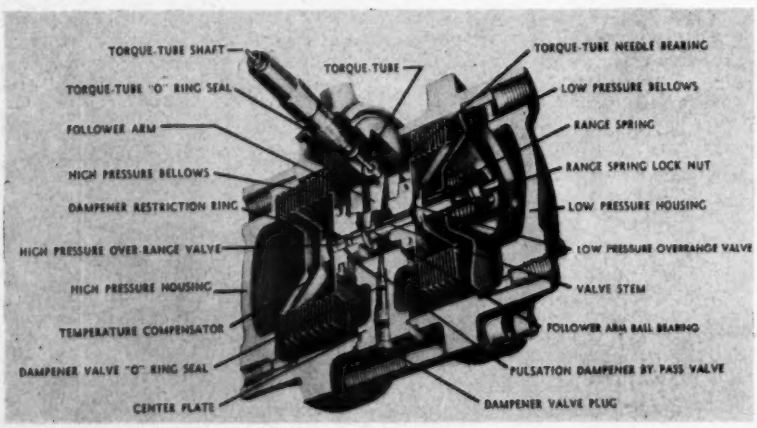
The measuring system described is repeated for a number of inlet and outlet measuring points, all outputs being continuously and instantaneously summated or subtracted in the form of electric signals in order to evaluate a final signal which represents the heat output from the reactor.

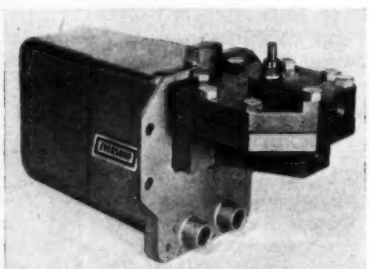
Standard instruments of Evershed & Vignoles Ltd. are used throughout the installation.

'Rotameters' with electrical transmission

Electrical transmission can be applied to *Rotameter* flow meters, so making them suitable for metering small flows below the range of the pneumatic transmitter, or for locations where there is no compressed air available, or for transmission over long distances. In industries where electrical instruments are more generally used the electrically operated transmission has the advantage of being better understood by maintenance personnel, while it also provides high accuracy and speed of response, particularly where receivers and transmitters are widely separated.

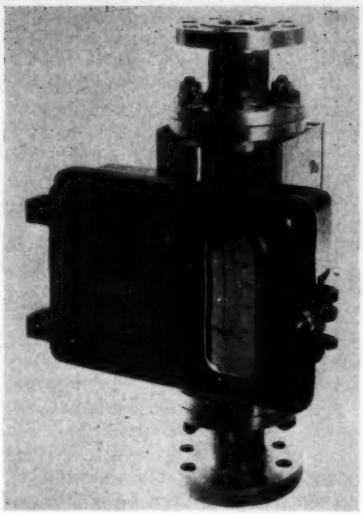
The *Rotameter* in its simplest form consists of a tapered tube, usually of glass, containing a float, the tube being installed in a vertical pipe with the larger end uppermost. The float is carried upwards by the fluid until a position of equilibrium is reached, the height of the float being a measure of the rate of flow, which can be read on a calib-

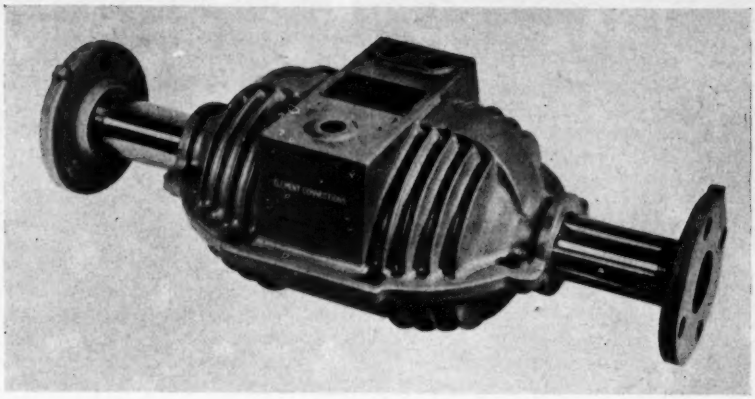




Left: **'Sunvic-Barton' differential pressure unit using a double-bellows system.**

Above: **Evershed transmitter, Type ER 125, as used in the heat flow measurement system described here.**





Left: **Pneumatic transmitting 'Rotameter,' type 400. This is similar in appearance and scope to the type 300 electrical transmitting type referred to below.**

Above: **The Foxboro magnetic flow meter, referred to on the opposite page and also on page 93.**

rated scale. There are numerous variations on this basic idea, the materials of construction and method of transmitting the float movement depending on the use envisaged. In some cases transmission is achieved through a magnetic coupling, and to this again a pneumatic or electrical transmitting unit can be fitted in addition to the direct-indicating unit. Rotameter Manufacturing Co. Ltd. are the makers.

The electrical transmitting *Rotameters* are again divided into a number of different types, and one interesting instrument is the type 300, which is similar in appearance and scope to the type 400 pneumatic transmitting unit. The float contains a magnet which provides a magnetic coupling through the wall of the metering tube to a separate indicator mounted in an enclosed case. The movement of this indicator is linked mechanically to a coaxial electronic repeater which provides a 0- to 30-ma. d.c. signal. A conventional four-bar linkage is used to provide arbitrary scale shape correction so that the output signal is linearly related to the flow passing through the instrument. This type of transmitter has been used successfully in computer control of process plants. The necessity of fitting a magnet in the float limits the smallest flow that may be metered to about 2 litres/min. of water and 45 l./min. of free air. This type of instrument has the advantage of providing direct indication in addition to a transmitted signal.

Double-bellows instruments

Flow meters for use with orifice plates, flow nozzles or venturi tubes are offered by Sunvic Controls Ltd. in forged or stainless steel. They are suitable for a wide range of process fluids and differential pressure measurements—liquid level, pressure drop, specific gravity, etc.—particularly as very high zero suppression is available.

Using a double-bellows system, with liquid fill, over-range protection up to full body rating is provided by use of over-range valves, and adjustable viscous damping is provided by a needle valve. Motion is brought out through a torque-tube, eliminating glands and friction; all moving parts are immersed permanently in the clean liquid fill.

Two models are available. One (model 11) has a *Sunvic* pneumatic motion transmitter attached to the body to convert rotation of the output shaft of the torque tube into a 3 to 15 p.s.i. signal. Local indication is obtained by connecting a pressure gauge into the body of the instrument. In the alternative (model 200) a mechanical indicator is coupled to the output shaft.

Standard differential ranges down to 0 to 4.35 in. w.g. and up to 0 to 50 p.s.i. are available. Safe working pressure in forged carbon steel or forged stainless steel is 2,500 p.s.i. and in forged *Chromaloy* steel it is 6,000 p.s.i. Ambient temperature limits are −25 to +200°F.

Sunvic controllers will accept any pneumatic signal derived from transmitters. Primarily intended for use in the standard 3 to 15 p.s.i. range, they will operate on any signal of 50 p.s.i. or less. There are no links, pivots, bearings or any wearing parts. They will work at ambient temperatures from well below 0 to over 100°C. and will withstand instantaneous acceleration of 120 g. with a zero error of less than 1%.

Some are designed for use with control stations and can be plugged-in to the rear of either indicating or recording types. Where high-speed control action is required, the instrument plugs-in to a manifold block which is mounted on the process plant, and piped back to the control room for display and auto/manual switching. These controllers incorporate cut-off relays.

Gas flow measurement with pressure and temperature correction

A pressure and temperature correction system developed in Germany permits the measurement of gas flows independently of the pressure and temperature of the gas. The equipment works in conjunction with an electro-mechanical or electro-pneumatic transducer with root extraction characteristic. The variables, *i.e.* temperature and pressure, are measured by means of a resistance thermometer and manometer with resistance-type transducer and the measured value is introduced into the compensation apparatus of the root-extraction transducer in such a way that the outlet current of the latter is proportional to the flow of the gas to be measured if the gas is in its normal condition. This is achieved by the use of a reverse-connected amplifier.

The method of operation is shown in the illustration on page 98. Lever (1), which is coupled with the pointer of the mechanically operated differential pressure gauge, tensions the measuring spring (2). The torque of this

spring is proportional to the angle of rotation M_F and thus proportional to the differential pressure. The torque M_F of measuring spring (2) is compensated by the torque *Me* of the electro-dynamic compensating meter. By means of the control flag (6) the shaft (3) of the compensating meter controls the scanning device, which consists of lamp (5) and photo-resistance (7), in such a way that the torque caused in the compensating device by the outlet current of valve (8) is equal to the torque of measuring spring (2). Current i_l controlled by valve (8) energises the winding of the resistance transducer (9) at the pressure gauge. The outlet terminals of the resistance tele-transmitter have a voltage $U_p = i_l R_p$. The compensating amplifier (10) works in such a way that its outlet current i_a causes, at the resistance thermometer (11), a voltage which is equal to the voltage U_p at the resistance transducer (9). Current i_a passes through the fixed coil of the electro-dynamic compensating device and the receivers which serve as current measuring instruments.

The makers of the equipment, J. C. Eckardt A.G., give technical data as follows:

Input value: 0 to 270°, or 0 to 1.0 kg./sq.cm. (according to type of measurements converter used).
Output current: 0 to 10 mA.
Permissible external resistance: (6,000 ohms max.), 3,000 Ω.
Converter accuracy: ±1.5% of result.
Main voltage: 220 volts ± 10 to 15%, 50 cycles.

Flow recorder

For the measurement of high-pressure gas, compressed air, steam, water and other liquids, the *Arkon* model 1602 flow recorder uses the principle of mercury U-tube and float, overload protection being provided. The instrument is fitted with a dual valve (instead of the three-cock assembly usually met with in this type of recorder), which incorporates automatic equalising. The possibility of mercury being blown into the impulse lines due to incorrect operation of valves or surges of pressure is thus eliminated, according to the makers. The operating valves are inside the recorder case and accessible from the front of the instrument.

Where the instrument is required to total the flow automatically, an electrically operated integrator can be fitted. Differential ranges from 60 to 200 in. w.g. The instrument, made by Walker, Crosweller & Co. Ltd., is designed for operations under static pressure up to 300 p.s.i.

Volumetric flow-rate calibrator

For calibrating small flow devices to accuracies within 0.2%, Brooks Rotameter Co. (U.S.A.) are offering a dry-seal, volumetric-type gas-collecting device. A volume of fluid is accurately measured and automatically timed as it passes through the unit being calibrated and then into a collecting chamber. The system employs a unique 'free-piston' operating in a straight wall precision-bore glass tube as the collecting chamber. A groove around the circumference of the piston is filled with mercury to form a perfect and virtually frictionless seal between the glass tube and the piston.

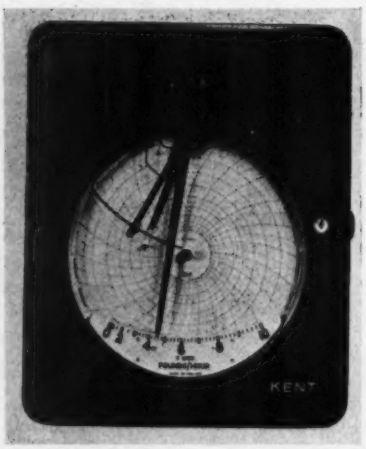
Elimination of vapour pressure, gas and liquid solubility factors, provision for hermetic sealing, and low constant back loading and extremely simple operation are claimed as advantages of this calibrator. It consists of a portable panel housing three precision-bore borosilicate-glass calibrating chambers, back-pressure indicator, gas-temperature indicator, selector valves, automatic dump valve, precision timer, electronic timing control, and automatic over-range protection. The system requires clean, dry gas at pressures no lower than 5 in. water column and 110 v., 60 cycle electrical energy for its operation.

Mercuryless recording instrument

A mercuryless diaphragm instrument for the measurement of differential pressures in six maximum ranges, and up to 2,500 p.s.i. working pressure, has been added to the *Commander* range of instruments by George Kent Ltd.

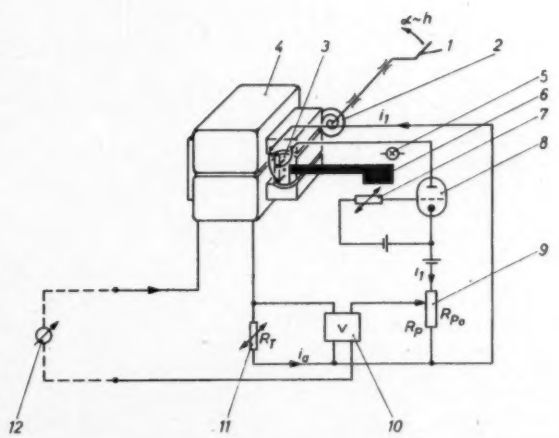
Intrinsically circular-chart recorders, sector-scale indicators and circular-scale indicators, they incorporate the *Barton* rupture-proof differential unit which, although employing sensitive bellows for its actuating element, may be subjected without damage to pressure differences equivalent to the pressure rating of the instrument. Full line pressure can be applied across the bellows unit in either direction owing to the valve in each bellows.

The torque-tube drive for conveying bellows movement to the instrument-index mechanism is leakage-free and virtually frictionless. Only the bellows exteriors are exposed to the metered fluid, and the unit is therefore completely self draining or venting, is without pockets to trap condensates and sediment formations and has no small tubes or other restrictions.



Left: **The 'Kent-Barton' mercuryless flow recorder-controller with crescent-scale indication.**

Right: **Measurement of gas flow with pressure and temperature correction. Components of this equipment, by J. C. Eckardt A.G., are explained in text.**



A Self-acting Automatic Flow Controller

By K. L. Butcher, B.Sc., Dip.Chem.Eng., F.R.I.C., M.I.Chem.E.
(*Chemical Engineering Department, University of Leeds*)

The advantages of a simple and reliable mechanism which will maintain a constant flow of liquid despite fluctuations of both supply and delivery pressure make the Flostat *a useful instrument in such diverse industries as atomic energy, the dairy industry, the dry cleaning of clothes, steel-making and chemical manufacture. In this article Mr. Butcher, who was chiefly responsible for its original development, describes this automatic flow controller and its uses.*

IN its present form the *Flostat* was first used in the laboratory of the chemical engineering department at the University of Leeds, where it was designed and developed in 1953. Commercial production was undertaken in the same year and there has since been a steadily growing use of this instrument in industry. It embodies a combination of well-known ideas, uniquely brought together so that liquids and, in some cases, gases or vapours may be made to flow at constant rates despite the action of disturbing influences.

Principles

It is well known that, when a liquid flows turbulently through an orifice, the difference between the pressures just upstream and just downstream of the orifice assumes a value which is proportional to the square of the flow rate. Any device which would act on the fluid flow rate in such a way as to maintain this difference in pressures at a constant value would thus keep the flow rate constant.

The first step is to measure this difference of pressures. Two principal methods have been used, the first being that of the differential manometer, a U-shaped column of mercury. Here the mercury takes up a position in the U tube dependent on the difference between the pressures applied to the ends of the tube.

In the standard *Flostat*, Fig. 1, another principle is used. A sensitive metal bellows *B*, of generally cylindrical shape, and having one end *D* closed but free to move, while the other end is fixed but open, is made to contract under the influence of the difference in pressures at the orifice plate *A*. The higher pressure is transmitted through an aperture *F* in the casting of the *Flostat* to a bell-shaped chamber surrounding the bellows. The lower pressure downstream of the orifice *A* is transmitted directly to the inside of the bellows by the flowing

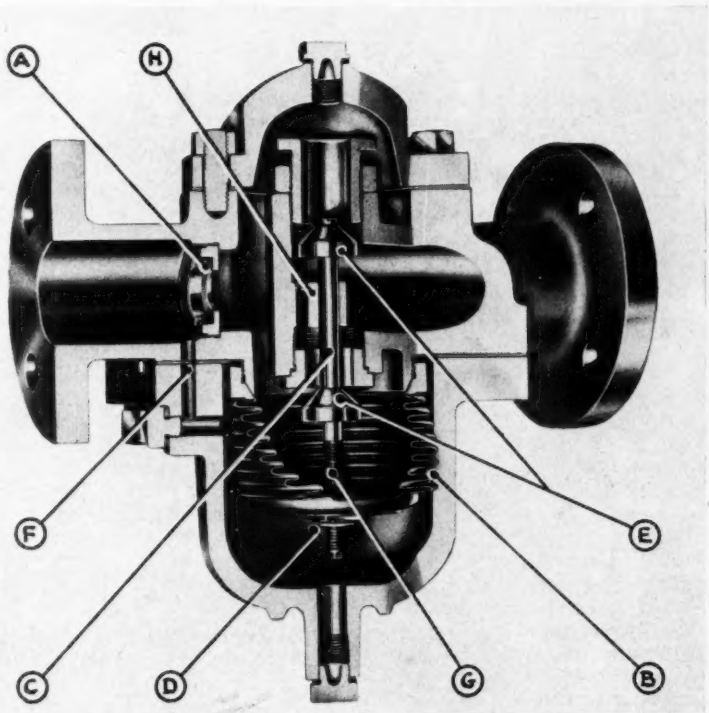


Fig. 1. Cut-away view of 'Flostat' automatic flow controller. Key to lettered components is given in the article.

fluid. Thus the amount of movement of the free end of the bellows from its position in the 'relaxed' state is a measure of the difference in orifice pressures and hence of the flow rate of the fluid.

The next problem is to use this movement of the mercury or free end of the bellows to cause some throttling action on the flow of fluid as soon as the movement approaches a magnitude determined by the desired rate of flow that is to be maintained constant. In the mercury manometer model, a steel cylinder, supporting a coaxial valve stem and valve heads, floats on the surface of the mercury in the low-pressure limb. In the standard *Flostat* a valve stem *G* is attached to the free end of the bellows and, when the latter is relaxed, the critical portions of the heads of the valves *E* are about $\frac{3}{4}$ in. away from their corresponding seats. Because it is important that the valve should be moved only by forces originating in the difference in pressures at the orifice plate, the two valve heads *E* are so sized as to minimise the net force due to the difference in the pressures just downstream and just upstream of the valve seats.

The size of the valve seats may be such that a pressure drop across the valve heads of about 1 p.s.i. will produce a flow in the control range

for the *Flostat*, when the valve heads are only a few hundredths of an inch away from their seats. The valve will have moved nearly $\frac{3}{4}$ in. from the 'relaxed' position to reach this throttling position. If the supply pressure is suddenly increased to, say, 25 p.s.i., the flow rate tends to increase, the bellows closes still further and, after it has moved a few thousandths of an inch, its throttling action has been so intense as to restore the flow to almost the original value. The new value is so near the first value that the difference is difficult to detect on a *Rotameter* flow meter. This is because the change in bellows position due to the change in pressure is only of the magnitude of between 1/100 and 1/1,000 of the total 'measurement' of $\frac{3}{4}$ in. The accuracy of $\pm 1\%$ change in flow value, maintained over a range of differences of supply and delivery pressures of, say, 2 to 150 p.s.i., is achieved by correct choice of size of *Flostat* and by the precision in their manufacture.

Accuracy and sensitivity

Fig. 1 represents a model of a *Flostat* which is 'set' by the manufacturers to achieve the flow rate desired by the users, who in turn have specified the maximum and minimum values of flow likely to be wanted, and the physical and chemical properties of the fluid. If frequent re-setting of the flows should be required, an external adjuster with position indicator is fitted on the bellows chamber. Accuracy is usually greatest at flows approaching maximum for a given orifice size and lies within quite close limits for all flows down to one-third of maximum. Even better results may be obtained (at greater cost) if higher accuracy of control is wanted, by replacing the orifice by a variable constriction instead of adjusting the valve stem *C*. In this case maximum travel of the bellows is used for all flows from maximum to one-third of maximum.

Since there is no gland to restrain the valve stem *G* and only a minute restraining force due to the guiding sleeve *H*, the rate of response of the valve to changes in conditions is remarkably high. This is because only a few ounces of metal and liquid have to be moved through a few thousandths of an inch, once the valve heads have reached the throttling position. Even the time taken to reach controlled flow of, say, 500 gal./hr. from zero flow in a $1\frac{1}{2}$-in. *Flostat* would be only 5 sec. The time to change from control at one pressure to control at another pressure, assuming an instantaneous change in pressures, is usually a fraction of a second.

Effect of shock loading

Experience shows, and theory explains, that the nature of the transient flow from the moment of suddenly opening the block valve in the *Flostat* line to the establishment of a constant flow, depends upon whether the block valve is located upstream or downstream of the *Flostat*, when a centrifugal pump is the source of pressure. The two effects are illustrated in Fig. 2 and occur as follows.

(*a*) When the downstream valve is left wide open and the upstream valve is suddenly opened, there may be a surge of flow for a second or so, provided the potential supply pressure is several times the pressure drop across the *Flostat* at 'control' flow. This surge may reach a value several times as large as the ultimate controlled value to which this peak flow is then reduced during the next second or two.

(*b*) If the upstream block valve is left wide open and the downstream valve is suddenly opened, there is markedly different response on the flow indicator, and it is difficult to find conditions which will cause overshooting of the control value of flow.

The explanation lies in the fact that the initial acceleration of the valve head depends upon the instantaneous difference in pressure between the bell chamber liquid 'outside' the bellows and the pressure inside the bellows. In the case of sudden opening of the upstream block valve, both sides of the bellows are initially at, say, atmospheric pressure. Since the *Flostat* valve is wide open a surge of flow takes place during which the pressure in the bell builds up to the supply pressure. At no time is there any pressure difference across the orifice of

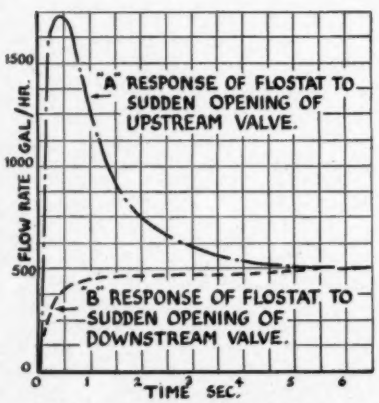


Fig. 2. Graph showing effect on 'Flostat' of shock loading.

the order of magnitude of the gauge pressure available at the pump delivery, although, paradoxically, the differential pressure across the bellows *due to flow* must be larger because of the 'surge peak flow' in case (*a*) as compared with (*b*).

In the case (*b*), where the downstream valve is suddenly opened and the *Flostat* valve chamber connected to the inside of the bellows drops from full pump pressure to, say, atmospheric pressure, there exists for a short time a high differential pressure across the bellows because the bell chamber outside the bellows was initially at full pump pressure. This high differential pressure gives the valve a high initial acceleration as compared with the initial acceleration in the previous case. The valve is thus carried more rapidly to its throttling position in the initial phases of its motion. This will probably account for the greatly diminished tendency to overshoot the desired control value under the influence of 'impulsive shock.' A small pocket of gas (or air) trapped in between the walls of the bellows chamber and the outside of the bellows would enhance this effect.

However, another feature of these responses to shock loadings is that the rate of change of the flow towards the final equilibrium value, as this value is being reached, in the later stages is greater in the downward direction in the first case, than the upward trend usually seen in the second case. This is explained by the valve acceleration now being proportional to the difference of the forces varying as the squares of the instantaneous flow and the spring force. In both cases the spring force is approaching its equilibrium value. The peak flow of the first type of shock thus gives the greater acceleration in the intermediate stages of the transient region, while the last phases of stabilisation would be similar in rate but opposite in direction.

Generally this type of response is not important and in any case depends appreciably on the magnitude of the controlled flow for a given size of *Flostat* as well as on the ratio of the maximum available liquid head to the head losses in the *Flostat* (say 5 ft.) under steady conditions of automatically controlled flow.

Applications

The availability of bellows made of various materials makes it possible to adapt the construction of *Flostats* to suit a wide range of media and of pressures. Where these alternative bellows materials appear to be unsuit-

able it is sometimes possible to utilise the mercury differential manometer principle or other pressure-responsive elements of non-metallic materials. Where very small flow rates are required a double-seated valve may be unnecessary and a much cheaper form of *Flostat* would be available. For the food industries the design of the instrument has been modified to ensure ease of cleaning, sterilising and inspecting internal parts.

Fluids that have been successfully handled with the *Flostat* include water (soft and hard), brine, trichlorethylene, fuel oil, concentrated sulphuric acid, sodium hydroxide solutions, liquid sulphur dioxide, low- and high-pressure steam, and compressed air. Working pressures up to 350 p.s.i. are satisfactorily handled in the smaller models.

In the control of gas flows the arrangement of the *Flostat* shown in Fig. 1 is suitable where the fluctuations in the upstream pressure are not sufficient to alter the density considerably, otherwise constancy in the weight rate of flow will not be within $\pm 1\%$ of the mean value. Where the delivery pressure of a gas is comparatively steady, the orifice plate would be located at the outlet of the *Flostat* and the action of the valves reversed.

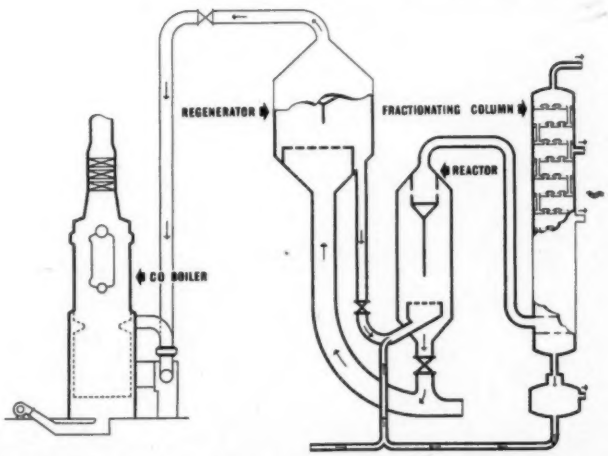
Commercial production of the *Flostat* is now being undertaken by G. A. Platon Ltd., Croydon, Surrey, a new company whose object is to concentrate on the standard models and to modify them to meet specialised needs.

Fawley refinery to have Britain's largest carbon monoxide boiler

The Fawley refinery of Esso Petroleum Co. Ltd. is to have Britain's largest carbon monoxide boiler, designed, manufactured and installed by Babcock & Wilcox Ltd. The boiler will utilise the flue gases, rich in carbon monoxide, produced during the catalytic cracking process, to generate 300,000 lb./hr. of steam at a pressure of 150 p.s.i. and a temperature of 465°F.

It is of the circular, vertical type surmounted by a steel chimney, with an overall height of some 250 ft., and will be used primarily to supply steam for the catalytic cracking unit. The boiler is also equipped with combined *Multispud* gas burners and oil burners for employing a supplementary fuel supply of either fuel oil or refinery gas or both.

The oil burners are used for starting up and, combined with the refinery gas burners, generate the initial supply of steam to the cracking unit. As the throughput of the cracking process increases the volume of carbon monoxide gas mixture increases, and the supplementary supply of fuel oil and/or refinery gas is reduced until a condition is reached when the ratio of supplementary fuel to carbon monoxide flue gas burned is in the proportion approximately of one-third to two-thirds and, under these conditions, the boiler will operate at full capacity. The boiler can, when using only the supplementary supply of fuel, maintain a full steam supply to the refinery even when the catalytic cracking unit is shut down.



Simplified diagram showing a carbon monoxide boiler operating from the flue gas of a fluid-type catalytic cracking unit.

Variable-area Flow Meters

(*Concluded from page 95*)

(2) Sensitivity within 0.05% full scale.
(3) Reproducibility, 0.25% full scale.
(4) Linearity, 1% of full scale.
(5) Full-scale speed of 0.5 sec.

Recorders and integrators

The float extension and magnetic clutch is similarly used to provide the input motion for integrators and the pen-arms of recorders. The motive power for the recorder chart is a clock mechanism, both electric and spring-wound clocks being used according to the needs of the user. Up to three additional recording pens may be added to the basic instrument to record other variables.

Control

Control of flow is achieved by normal methods with the controller mounted externally or within the flow meter case.

The 10-to-1 range of a variable-area flow meter gives flexibility of the set point required and on many instruments the metering tube and float can be quickly changed to accommodate increases in throughput of the plant.

The linear scale and large range are especially useful when metering for the calculation of mass flow or for ratio control (Fig. 4).

Conclusion

The simplicity and adaptability of the variable-area flow meter have led to its widespread use in industry, where it can be used in preference to the orifice method of flow metering on the grounds that a linear scale, wide range and accuracy of $\pm 2\%$ constitute appreciable advantages.

FERTILISER PROCESSES

The French chemical firm, Potasse et Engrais Chimiques, have given an exclusive licence for their fertiliser processes, covering the United Kingdom and Eire, to Humphreys & Glasgow Ltd.

Plants using these processes are already in operation in France, Germany, Sweden, Finland, Formosa and the United States. Another is being brought on stream at the £30-million A.N.I.C. synthetic rubber and fertiliser plant at Ravenna, Italy.

In the French processes, phosphate rock is acidulated with nitric acid. The resulting slurry is then neutralised with ammonia, with precipitation of dicalcium phosphate.

The AMERICAN Scene

A quarterly summary of recent happenings in the United States

Latest news of the Eastman process for the simultaneous production of acetylene and ethylene from light hydrocarbons (see CHEMICAL & PROCESS ENGINEERING, 1958, **39** (2), 37) is that it is going to be made available on a licence basis to manufacturers in the U.S. A contract has already been signed between the originators of the process, Tennessee Eastman Co., and Stone & Webster Engineering Corporation, under which Stone & Webster will design and construct commercial plants.

The design of these plants will be based on experience at the works of Chemische Werke Huls, Germany, and the results of Eastman research and development. At Huls, a commercial-scale unit of Eastman design has operated successfully for several months.

Tennessee Eastman have been carrying out work in this field for many years. In developing the process, a new type of cracking furnace was devised. Furnaces having annual capacities of 1 million lb. of products have been operated for extended periods, and yields of more than 50% by weight of products from the raw material fed to the furnaces were obtained.

The Eastman process can use various light hydrocarbon feedstocks such as liquefied petroleum gases and natural gasolines. By-product gas streams from the process (nitrogen, carbon monoxide, hydrogen, and carbon dioxide) can be used to make ammonia, urea, methanol, etc.

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Producer for a long time of metals and alloys used by the steel industry, including calcium, titanium, vanadium, tantalum, columbium, chromium, silicon, tungsten, manganese, boron, and zirconium, Union Carbide now plans to produce chemical derivatives of these and other metals. The company will emphasise chemical derivatives of the less common metals, compounds which have been relatively little explored up to this time. The new product line now includes anhydrous metal chlorides and oxychlorides which are intended as intermediates for the production of other metal derivatives. These compounds are much in demand at present as catalytic agents in the rubber and plastics industries. Their use in the production of polyolefins is typical.

Other types of metal chemicals which Union Carbide has begun testing and for which it is planning pilot production include finely divided metal oxides, metal carbonyls, organic derivatives such as esters and acetylacetonates, and metal salts.

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Polythene-coated corrugated board is seen as a potential major outlet for polythene and might well have some effect on the future growth of the polythene industry. The vastness of the corrugated-board industry can be seen in the fact that 6,879,400 tons of board were produced in 1957 and if polythene could find application in even 1% of this total the resulting tonnage of polythene-coated board would be nearly twice as much as the combined tonnages of paper and paperboard which were extrusion-coated with polythene in 1957. About 20 million lb. of polythene were consumed in extrusion coating of these substrates last year.

One polythene producer which feels that the corrugated-board field has definite promise is U.S. Industrial Chemicals Co., and a spokesman for the company predicts that the bulk shipment of foodstuffs will provide the biggest use. The low-friction surface provided by polythene is also claimed to make polythene-coated packs suitable for glass, and for painted or highly polished objects which are subject to scratching.

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The first step towards fully automatic control of their cement manufacturing plant has been taken by Riverside Cement Co., Los Angeles, with the purchase of an electronic digital computer which will guide the operation of a new completely mechanised rock-blending plant at Oro Grande, California. It is expected that the use of a computer will help the company to produce more cement of more uniform quality at lower operating cost.

Along with the new crushing and blending system, plans are at present under way to increase the plant's kiln capacity. The first increment of this increase is scheduled to be in operation by April 1 this year. Rated capacity of the Oro Grande plant at present is over 5 million barrels p.a.

In addition to its control functions the computer, manufactured by Thompson Ramo Wooldridge Inc., will collect and analyse data needed in planning automatic control systems for the entire cement manufacturing process. The computer system, as it is to be initially installed, will cost about $130,000.

The computer will keep track of the amount, chemical composition and point of origin of thousands of tons of rock and other raw material loaded into the new blending plant. It will periodically calculate how much of what kinds of materials should be added to the pile to obtain the proper proportion of cement-making ingredients. The computation will indicate the most economical action to take on the basis of such factors as hauling

distances and cost of quarrying in various areas.

Analysis of rock samples will continue to be accomplished with an *x*-ray spectrometer, and the computer will automatically bring in data from the spectrometer and perform all necessary calculations, including calibrations. In addition to making control computations, the computer will log data from the plant's rotary kilns. It will provide accurate and continuous records of such variables as temperature, fuel gas, gas flow and rotation speed.

$

American Potash & Chemical Corporation's new $4,300,000 sodium chlorate plant at Aberdeen, Miss., went on stream last month. Designed for an initial production of 15,000 tons p.a. of sodium chlorate, it was constructed primarily to supply chemicals to the rapidly growing southern pulp and paper industry for bleaching pulp and paper. Sodium chlorate also is used in weed killers and cotton defoliants.

Production at Aberdeen, combined with sodium chlorate output at the company's Henderson, Nev., plant will total some 40,000 tons p.a., about 45% of current domestic consumption, and will make A.P. & C.C. the largest producer in the United States.

Aberdeen plans allow for the expansion of sodium chlorate production facilities to meet future demand or to manufacture oxidisers. At Henderson, American Potash has the only existing large-scale facility for manufacturing ammonium perchlorate.

$

Completion of a $15-million bulk marine terminal and the adjacent $55-million alumina plant was marked with dedication ceremonies at Burnside, La., recently. The terminal is the largest facility for handling bulk cargo in the Gulf Coast area. The alumina plant is part of Ormet Corporation, the nation's newest and fourth largest producer of primary aluminium—jointly owned by Olin Mathieson Chemical Corporation and Revere Copper & Brass Inc.

The Burnside alumina plant started full production late last year and five barge tows, each consisting of an average of 15 barges, have transported a total of approximately 100,000 tons of alumina to the Ormet aluminium reduction plant located near Hannibal, Ohio. Ormet's Ohio facility is the second largest aluminium reduction plant in the country.

$

American tellers of tall tales received a rude jolt when, in a lie-telling competition held during the recent Dairy Industries Exposition in Chicago, the grand prize for telling the biggest 'whopper' went to—an Englishman! This was Mr. F. J. Clarke, managing director of the London dairy engineering and food machinery firm of Clarke-Built Ltd., and the tale which his audience had to swallow was:

It is very well known that dairymen in London, England, have tremendous difficulties to overcome when delivering milk during the foggy seasons, and research to overcome this has produced some startling results. Cows are now being fed a diet which contains a phosphorus additive, and the resulting milk has a fog-penetrating glow. This means that the breath of the cows glows in the fog, making them easier to find for milking, while bottles of milk light up in the fog, making them easily visible on the customers' doorsteps. An additional benefit was that adults and children who drink milk exude breath plainly visible in the densest fog, thus cutting down the accident rate.

Also, according to Mr. Clarke, slogans issued by the Milk Publicity Council include 'Drink Milk and Light Your Way Home' and, a very popular one, 'Get Lit Up On Milk.'

The new Burnside, La., marine terminal and Ormet Corporation's alumina plant.

Industrial Publications

Diaphragm pump. Details of the *Keebush* diaphragm pump made by the Kestner Evaporator & Engineering Co. Ltd., 5 Grosvenor Gardens, London, S.W.1, are given in the company's leaflet No. 301. In this pump, which is glandless, self-priming and suitable for acids and acid slurries, the body is of *Keebush* synthetic resin and the diaphragm and ball valves of synthetic rubber and flexible plastics.

Pressure vessels for widely varying purposes built by Cochran & Co. Annan Ltd., Annan, Dumfriesshire, are illustrated in a booklet issued by the company. The vessels cover a large range of sizes and working pressures.

Lubricants. Publication No. 3D from Rocol Ltd., Swillington, near Leeds, is a guide to the use of molybdenised lubricants in industry. It explains the nature, physical properties, commercial specification and applications of molybdenum disulphide.

Electric motors. Metropolitan-Vickers Electrical Co. Ltd., Trafford Park, Manchester 17, invite oil and chemical engineers to apply for their 220-page book on this subject. It is divided into three sections: flameproof equipment, general information and non-flameproof equipment. It lists equipment available, gives detailed information to facilitate the selection of equipment for a particular purpose and reference is also made to the requirements of British and American inspection and standardisation authorities.

Company News

I.C.I. has brought into operation a large-scale development plant for the manufacture of high-quality silicon of semi-conductor grade which costs over £100/lb. and has become of commercial importance in the manufacture of devices such as transistors.

The plant is operated by the General Chemicals Division on Merseyside. By the middle of this year capacity will approach 4,000 lb. p.a. Lump silicon, *p*-type, of resistivity greater than 200 ohm/cm., is available in quantity, and silicon in rod form for zone refining, deposited direct from vapour and of exceptionally low boron content, is being produced in limited quantities in lengths of 24 in. and up to 1 in. diam.

To date, much of the silicon used in Britain has come from America or France. Now I.C.I. will be able to satisfy the demand in Britain and later expects to export.

*

Keelavite Hydraulics Ltd., of Allesley, Coventry, have appointed Elettro Tecnica Apparecchiature as their agents in Italy for the sale of hydraulic installations and units. E.T.A., who were formed in 1949, are able to offer a technical consulting service on hydraulics. Their head office is at Piazza Guastalla 15, Milan.

*

Shell Chemical Co. Ltd. announce that they are proceeding with the construction of large-scale polyolefin manufacturing facilities which will be installed at the Carrington works (formerly known as the Partington works) of Petrochemicals Ltd. The first stage embraces the production of some 30,000 tons p.a. of polythenes and polypropylenes, including high-density polythenes manufactured under Ziegler licence.

*

Q.V.F. Ltd. have appointed the Corning Glassworks, of Corning, N.Y., as agents for the U.S.A. Some £10,000-worth of industrial glassware has already been shipped as part of an initial order.

A. F. H. Devers & Co. (Pty.) Ltd., of Selby, Johannesburg, have been appointed Q.V.F. distributors in South Africa.

*

I.C.I. and Farbenfabrik Bayer have bought licences and patent rights from the Norwegian firm Sunde Fabrikker, Spjelkavik, for £25,000 each. The deal is for a new process for manufacturing foam plastic insulation of water pipes. The contract also comprises royalties and manufacturing machinery.

*

Victor Products (Wallsend) Ltd. announce the reorganisation of their home sales organisation to cover an increasing range of equipment. The district offices will be in Leicester for the East Midlands area; Lichfield, for the West Midlands; Glamorgan, for South Wales; Croft, near Warrington, for the north-western area; Doncaster, north-eastern; Edinburgh, Scotland; London for the southern counties. Northumberland, Durham, Westmorland and Cumberland will be covered by the home office.

*

Change of address

Sunvic Controls Ltd. announce that their London office is now at Crown House, Aldwych, London, W.C.2.

*

The Morgan Crucible Co. Ltd. have moved to larger premises. The sales office is now at Wandsworth Works, Point Pleasant, Wandsworth, London, S.W.18, and a new factory and laboratory have been established there for the production and development of *Sinterlink*. This combines plant and facilities previously situated at Battersea, and Norton, Worcester.

Orders and Contracts

More than £70,000-worth of plastics mixing machinery for the Soviet Union has been ordered from Morton Machine Co. by Techmashimport, Moscow. The machines are for plasticising PVC, PVA and kindred materials by the 'dry powder' method, each handling 500 lb./hr. of plasticised powder and being capable of continuous discharge through twin barrels.

The Soviet order includes a number of preheated plasticiser containers for use with the mixers.

*

Another order from Techmashimport is for a large spray-drying plant for sodium sulphate, to be delivered this year by Kestner. It will comprise the complete spray drier, all-electric driving motors and product-conveying equipment. Producer-gas fired, it will employ a centrifugal atomisation system, the production capacity being in the region of 5,000 lb./hr. of dried sodium sulphate.

*

A gas turbine supplied by a British company is to be used in the production of polythene at Canadian Industries' plant in Alberta. Manufactured by Ruston & Hornsby, it is a 'T.A.' unit normally rated at 1,260 b.h.p., and will replace a steam turbine to drive a refrigeration compressor.

It is interesting to note that the C.I.L. polythene plant uses natural gas obtained from local sources as the main raw product, and the turbine will burn the gas after the ethane has been extracted to produce ethylene, which in turn is converted to polythene. In effect, this means that the turbine will utilise a partially waste product as fuel.

Over two miles of glass piping with 6,000 separate glass parts, designed and installed by Q.V.F. Ltd., make up the fluid waste system to be installed in the new chemistry building now under construction for Nottingham University.

This is the company's largest single order for this type of job. Piping in lengths varying from 6 in. to 12 ft. and with internal diameters of from 1½ to 4 in., will be used. There will be 32 vertical stacks of 3- and 4-in. material and 250 sinks with some 700 glass drip cups and traps set in benches and fume cupboards.

*

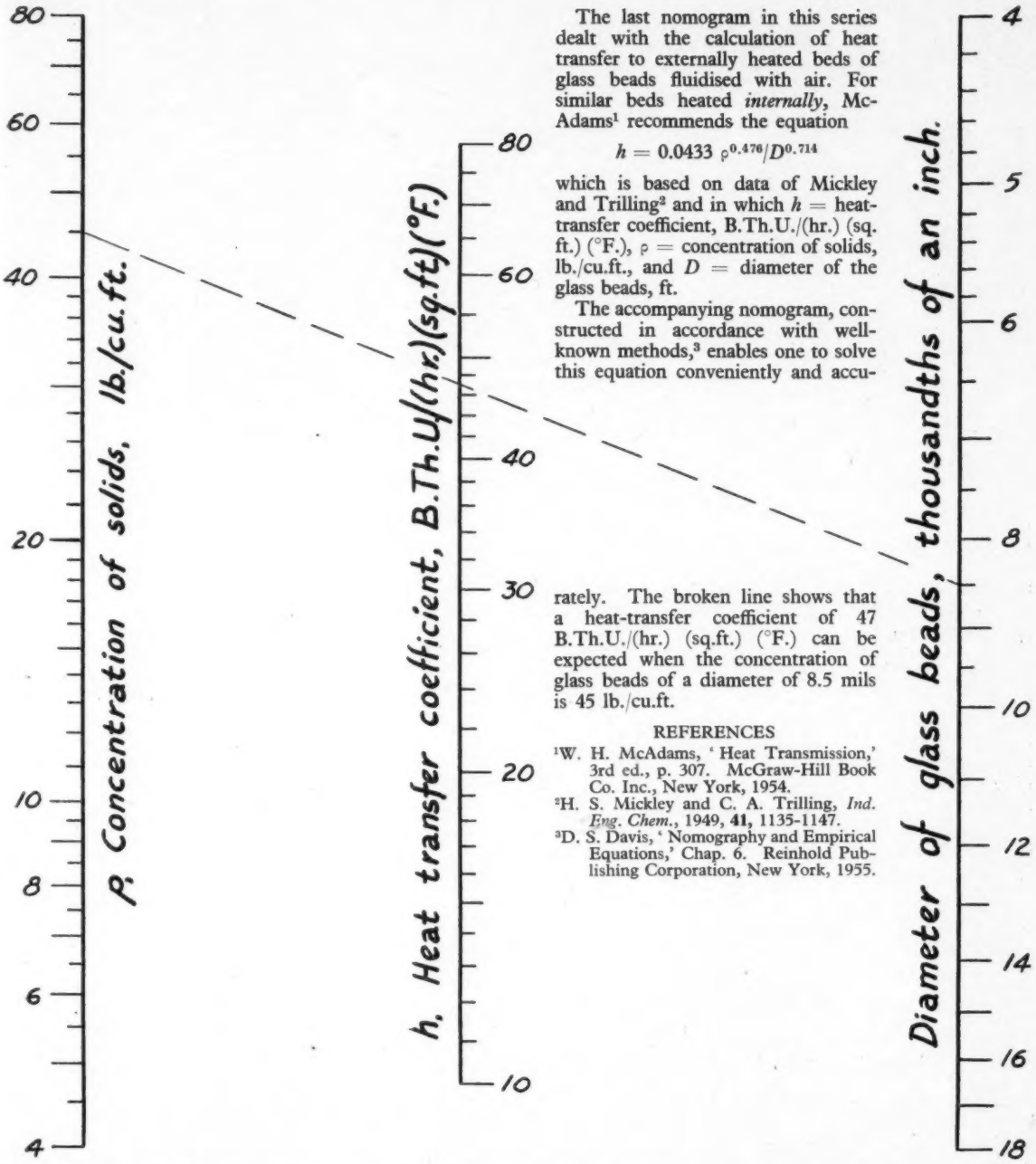
A Polish order for continuous fish meal and oil plants, valued at £85,000, has been received by Farrar Boilerworks Ltd. The plants, of a new type, each have a capacity of 25 to 30 tons/day of raw, oily fish. They will be installed on factory trawlers which are being built at Gdansk.

The equipment includes machinery for shredding the raw fish, a feed regulator which stores fish in the hopper and feeds it to the main processing plant, and a raw fish conveyor from the feed regulator to a steam-jacketed pre-cooker.

For oily fish operation, the material goes direct to a fish oil press in which the moisture and fish oil is expelled. Liquor is then passed over a vibrating strainer where the tailings or solids are separated from the liquor and fall into the 'press-cake' conveyor to be transported to the drying unit where it is dried into fish meal. If necessary, the meal can be recirculated. The liquors pass to a settling tank.

NOMOGRAM
By D. S. Davis

Heat Transfer to Internally Heated Beds of Glass Beads Fluidised with Air



The last nomogram in this series dealt with the calculation of heat transfer to externally heated beds of glass beads fluidised with air. For similar beds heated *internally*, McAdams[1] recommends the equation

$$h = 0.0433\ \rho^{0.476}/D^{0.714}$$

which is based on data of Mickley and Trilling[2] and in which h = heat-transfer coefficient, B.Th.U./(hr.) (sq. ft.) (°F.), ρ = concentration of solids, lb./cu.ft., and D = diameter of the glass beads, ft.

The accompanying nomogram, constructed in accordance with well-known methods,[3] enables one to solve this equation conveniently and accurately. The broken line shows that a heat-transfer coefficient of 47 B.Th.U./(hr.) (sq.ft.) (°F.) can be expected when the concentration of glass beads of a diameter of 8.5 mils is 45 lb./cu.ft.

REFERENCES

[1]W. H. McAdams, ' Heat Transmission,' 3rd ed., p. 307. McGraw-Hill Book Co. Inc., New York, 1954.

[2]H. S. Mickley and C. A. Trilling, *Ind. Eng. Chem.*, 1949, **41**, 1135-1147.

[3]D. S. Davis, ' Nomography and Empirical Equations,' Chap. 6. Reinhold Publishing Corporation, New York, 1955.

FUTURE NOMOGRAMS to appear in this series will deal with: Heating and Cooling of Gases in Tubes, Heating and Cooling of Gases Flowing Normal to Staggered Tubes, Pressure Drops Across Wet Drained Columns, Heat Transfer Coefficients for Condensing Steam, Thermal Conductivities of Metal Walls, Thermal Conductivity of Insulating Materials, Linear Velocity of Air in Ducts.

Personal Paragraphs

★ **Mr. G. K. Hampshire,** chairman of I.C.I.'s General Chemicals Division, and **Dr. J. S. Gourlay,** chairman of the Paints Division, have been appointed to the board of I.C.I. Mr. Hampshire joined Brunner Mond in 1923 and, in 1933, he was appointed sales manager of I.C.I.'s General Chemicals Group, becoming a group director in 1937. Two years later he was appointed managing director of the General Chemicals Division and in 1947 he became chairman. Dr. Gourlay started as a laboratory apprentice with Nobels' Explosives Co. Ltd. at Ardeer. He became research manager of the Paints Division in 1945 and its chairman in 1957.

★ **Mr. F. W. P. Holt,** who has been a director of Widnes Foundry & Engineering Co. Ltd. since 1925 (when it traded under the name of Widnes Foundry (1925) Ltd.), has retired. The name of the company was changed when it was taken over by Thos W. Ward Ltd. in 1936. During Mr. Holt's service with the company it has developed into one of the best known manufacturers of special-purpose castings for the chemical, oil, food and allied industries.

★ **Mr. C. E. Walters** has been appointed general sales manager of Sunvic Controls Ltd., but is retaining responsibility of the domestic products division.

★ **Mr. W. J. Piggott** will retire from the board of Laporte Industries Ltd. at the end of this month, because of ill-health, after 52 years of continuous service. **The Hon. F. A. Leathers** and **Prof. F. S. Spring** have been appointed directors. Prof. Spring is at present Freeland Professor of Chemistry at the Royal College of Science and Technology, Glasgow, and will take up the executive appointment of director of research of the Laporte Group on July 1. **Mr. V. W. Slater,** a director, will continue as chief chemist of the group.

★ **The Hon. J. K. Weir,** C.B.E., chairman of G. & J. Weir Holdings Ltd. and G. & J. Weir Ltd., has been elected a director of the International Nickel Co. of Canada Ltd., and a member of its advisory committee.

★ **Mr. B. Pollard,** of Constructors John Brown Ltd., recently flew to New York to establish an office for the sale of *Kittel* plates in the United States. Constructors John Brown have held the licence for the design, manufacture and sale of *Kittel* plates within the U.K. and Commonwealth since 1954. They recently acquired similar rights for the U.S.A.

★ Dewrance & Co. Ltd. announce that **Mr. A. Brown,** formerly chief assistant to the company's sales manager, **Mr. B. S. Bass,** has been appointed assistant sales manager. He is closely associated with the sales of special valves designed for service in nuclear power plants.

★ Midland Silicones Ltd. announce the appointment of **Mr. J. Acton** to the new post of new products manager. He will be responsible for launching and marketing all new silicone, or silicone-containing, products developed by Midland Silicones. He first joined the company in 1955 as a technical representative and latterly has been in charge of sales in S.E. England.

★ **Dr. J. M. Blocher, Jnr.,** has been appointed chief of Battelle Memorial Institute's division of inorganic chemistry and chemical engineering. In his 12 years at the Columbus, Ohio, research centre, he has been closely associated with studies in fields including thermodynamics, high-purity metals, and vapour-deposited refractory coatings.

★ **Mr. J. Simpson** has been appointed deputy chairman of Woodall-Duckham Construction Co. Ltd. He joined the company in 1926 and was for many years on the sales side of the business. From 1943 until 1955 he was responsible for the activities of the company relating to the purchasing of supplies and the planning of contracts. He was appointed director in 1946 and a joint managing director in 1955. Mr. Simpson in future will carry special responsibilities relating to the operations of the growing number of subsidiary companies within the Woodall-Duckham Group at home and overseas.

★ **Mr. E. N. Wenborn** has been appointed a joint managing director of Woodall-Duckham. He joined the company in 1924, trained in the drawing office and from 1928 to 1944 carried on the duties of outside construction engineer on a number of contracts for the gas and coking industries. In 1944 he returned to the head office as group engineer in the construction department, being in charge of a number of large contracts, and was appointed chief engineer, supplies and services, in 1955. He was appointed to the board in January 1957.

INDUSTRY REPORTS . . .

Outlook for German nitrogen

Commenting on the European Common Market idea, at the tenth anniversary of the Specialist Association of the Nitrogen Industry in Dusseldorf, Dr. Timm, deputy chairman of Badische Analin & Soda Fabrik A.G., considered the outlook for the German nitrogen industry to be satisfactory if it is offered the same possibilities for obtaining raw materials as the nitrogen industries in the other O.E.E.C. countries.

He also pointed out that the plant available for ammonia itself and its processed products is quite sufficient to satisfy all the requirements of the European market for some years to come, and that the injudicious construction of further nitrogen plants would endanger the profitability of the existing ones. He therefore suggested that there should be no further extension of nitrogen plants in Europe and recommended German nitrogen producers not to erect new factories for the manufacture of complete fertilisers.

Old plant v. new

In his statement circulated for the 28th annual general meeting of Colevilles Ltd., Sir Andrew McCance spoke of the advantages of the modern facilities at Ravenscraig works. The blast furnace maintained an output in excess of its rated capacity of 7,000 tons/week and the company is confident that when required an output of 9,000 tons/week can be obtained. Progress in the development and operation of the furnace and the sinter plant had reduced the coke consumption for long periods to very low figures.

Unfortunately, the reduction in operating costs which high production can achieve is often offset under present conditions by the depreciation charge required for the very expensive plant necessary to bring it about.

Since the company manufactures at Mossend engineering works some of the steelworks plant required for their own development plans they are in a position to compare the advances in manufacturing costs. Expressing costs per ton of machinery in 1938 as 100, the cost today is 425 and the company believe that these figures are comparable with other makers.

World News

AUSTRALIA

Sulphuric acid from petroleum

Manufacture of sulphuric acid as a by-product of the crude-oil refining process has begun at the recently opened plant of Shell Chemical (Australia) Pty. Ltd. at Geelong. This £A700,000 plant is the second petrochemicals enterprise to begin production in Australia. The sulphuric acid produced is to be used for the manufacture of superphosphate.

Output from the new plant will result in a considerable saving in imports of natural sulphur for acid manufacture. It will also provide acid for use by secondary industry. Output will be 100 tons/day. The plant is adjacent to the Shell refinery which treats nearly 2 million tons of imported crude oil.

Following the opening of the sulphuric acid plant and their decision to build an *Epikote* resin plant at Clyde, Sydney, Shell Chemical (Australia) are to build a detergent alkylate plant at Geelong. This plant, which will cost over £A1 million, is due for completion in early 1961.

Chemical projects

Australian Carbon Black Pty. are erecting a £A2-million plant at Altona, Victoria. Newcastle Chemical Co. have more than doubled their production of phthalic anhydride. Wah Chang (Australia), already established in Victoria, is to manufacture pesticides in Queensland.

UNITED STATES

Calcining petroleum coke

A plant for calcining petroleum coke is to be constructed near Purvis, Mississippi, by Kaiser Aluminium & Chemical Corporation. The coke is used in the manufacture of carbon anodes for the electrolytic cells in the company's primary aluminium reduction plants.

The Purvis refinery of Pontiac Eastern Corporation will supply the petroleum coke. Construction of the calcining plant is scheduled to begin in the near future. It will include a rotary kiln and related handling facilities, with a capacity for calcining approximately 70,000 tons p.a. of coke. Investment in the plant will total about $500,000.

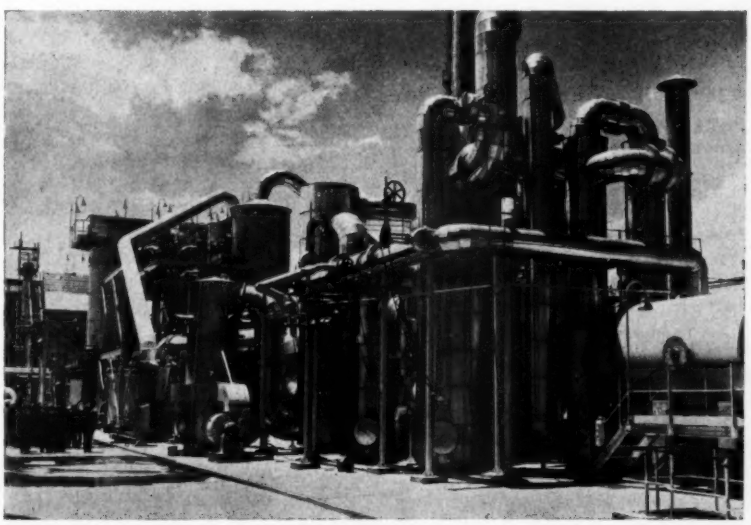
Nuclear fuels

Mallinckrodt Chemical Works has formed a separate company, Mallinckrodt Nuclear Corporation, to carry out its privately-owned nuclear fuels business. The new concern will take over the Mallinckrodt Special Metals Division, including a $2-million nuclear fuel production centre at Hematite, situated 45 miles south of St. Louis, Missouri, which has processed over 150,000 lb. of enriched uranium since 1956.

COLOMBIA

Chemicals

A factory for the production of sodium silicates is expected to commence production soon. It is stated that the production will be in the vicinity of 9,000 tons p.a., which will more than satisfy local demand. It is reported that the same company will shortly commence construction of a factory for the manufacture of calcium carbide, and that the plant will be based on a design supplied by a European firm of constructing engineers.



Treatment units of the Shell sulphuric acid plant, Geelong, Australia.

CHILE

Solvents and fertilisers

The new industrial solvents plant at Concon, constructed under the auspices of the Empresa Nacional de Petroleo and with the technical advice of the M. W. Kellogg Co., is expected to cover Chile's requirements of these products up to 1969 with an annual saving of U.S.$700,000 of imports.

It has been announced that C.O.R.F.O. and its subsidiary, the Sociedad Chilena de Fertilizantes, are studying a proposal for the establishment of a phosphate fertiliser plant in the Maule area. A technician from C.O.R.F.O. has visited Western Germany to carry out technical studies connected with the proposal.

GREAT BRITAIN

Thermal reformer

A 12,000-bbl./short-day thermal reformer has recently been brought on stream at the Kent refinery of B.P. Trading Ltd. It has been designed by Kellogg International Corporation for single-pass thermal reforming of either light or heavy naphtha fractions from Middle East crudes to produce a debutanised reformate of maximum research octane rating. The unit is also capable of handling *Platformates* of similar boiling ranges.

Continuous operation of the unit for at least 2,000 hr. was an essential design requirement and in order to implement this two 6,000-bbl./short-day reforming furnaces were provided. Either furnace can be taken out of service for decoking and brought back on stream without interrupting the operation of the other furnace or, indeed, of the entire unit although, of course, the feed rate to the unit has to be reduced when decoking one furnace.

Windscale's 'Hero'

A new low-power research reactor is to be built at Windscale, which is being expanded as one of the national centres for the development of gas-cooled reactors.

The new reactor will be known as *Hero* (hot experimental reactor of 0 power). It will cost about £1¼ million and will be built near the advanced

gas-cooled reactor (A.G.R.) on which work has already started. Its function will be to complement the work of A.G.R. by making it possible to carry out low-radiation-level measurements and to experiment with several alternative arrangements of fuel to obtain the best results.

It will be completed early in 1961 and will be operated and studied by physicists of the Research and Development Branch at the Windscale laboratories.

Hero, which will generate a few kw. of heat, will consist initially of a graphite structure 19 ft. in diam. and 19 ft. high, but an important feature is that it will be possible to dismantle it and rebuild it in a variety of ways. The graphite core will be contained in a steel vessel connected to a pipe circuit with pumps and heaters so that it can be operated at high temperature in carbon dioxide. It will, in fact, be the reverse of the A.G.R. since the carbon dioxide gas will supply heat to the core instead of removing heat from it. The fuel will consist as in A.G.R. of clusters of rods of uranium oxide sealed into beryllium cans, and these will be arranged in channels in the graphite on a regular lattice.

HUNGARY

Pipeline link-up

The 227-mile pipeline which brings methane gas from Buciumen in Rumania to industrial plants in north-east Hungary has been linked up.

The gas is for conversion into synthetic raw materials at a new industrial complex beside the River Tisza. Until the chemical plant is ready the gas is being used to fire the 200,000-kw. central power station at Tiszapalkonya and is being piped on to the twin towns of Diósgyör (where it will fire the Lenin Steel Works furnaces) and Miskolc. The Rumanian gas is almost pure methane, with a calorific value of 8,400, which is twice as high as that of the best Hungarian coal.

The Leonard Hill Technical Group—March

Articles appearing in some of our associate journals this month include:

Petroleum—Gas Liquid Chromatography; Royal Dutch Shell at Home; Oilfield Development; Skin Protection against Petroleum; Safety in the Refinery.

Paint Manufacture—Preview of Oil and Colour Chemists' Association Technical Exhibition; How Paints Stand up to Tropical Climates; Instrumental Control of Temperature.

Food Manufacture—Factory Visit to R. Fry & Co. Ltd.; Soft Drinks; The Problem of Improving Nutritive Value, 7; The Baking Industry; Meat.

Dairy Engineering—Boiler House Maintenance for Economical Performance; Electropolishing—A New Method for Cleaning Stainless-steel Vessels; Aluminium Milk Cans; Instrumental Control and Automation in the Dairy Industry, 2.

World Crops—Grain Handling Equipment; Grain in International Trade: A Review of Methods of Infestation control; Farm Grain Stores; Maize in Rumania.

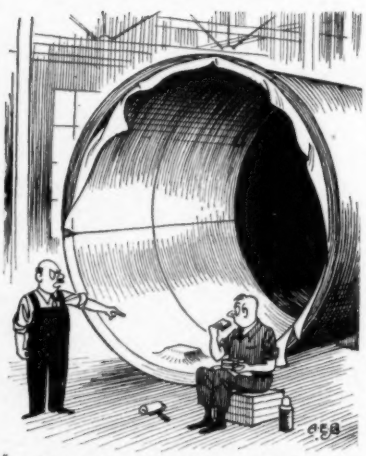
Atomic World—Special issue describing the latest processes for manufacturing fuel elements from uranium ores.

Corrosion Technology—Elastomers Solve the Corrosion Problem; Neoprene Linings for Large and Small Pipes; Protective Coatings and Linings in Neoprene; Sheet Neoprene Linings for Chemical Plant; High-Nickel Alloys in the Petroleum Industry, 1.

Fibres—Flax and its Future; Warp Sizing Agents; *Refrasil* in Industry.

Manufacturing Chemist—Heating, Ventilating and Insulating in Chemical Factories; Price's (Bromborough) New Fatty Acids Plant; Amphoteric Surface-active Agents.

Comical Engineering Corner



"I WISH YOU'D BE MORE CAREFUL, FRED — THAT'S MY LUNCH"

MEETINGS

Institution of Chemical Engineers

March 10. Symposium on Fluidisation, all day, Manchester College of Science and Technology, Jackson Street, Manchester.

March 17. 'Methods of Improving Heat Transfer from Condensing Steam and their Application to Condensers and Evaporators,' by J. J. Brunt, J. F. Hinsley, J. T. Shelton and R. G. H. Watson; 'Residence Time Studies in a Spray Drier,' by G. Place, K. Ridgway and Prof. P. V. Danckwerts; 'Entrainment in Turbulent Fluid Jets,' by Prof. M. B. Donald and H. Singer; 'Entrainment in Evaporators,' by Prof. F. H. Garner, Prof. S. R. M. Ellis and J. G. Shearn; 'Pumping Studies on Thoria Slurries,' by R. Murdoch and H. A. Kersey; 'Purification of Hydrogen for Distillation,' by W. H. Denton, R. Gayler and B. Shaw, 9.30 a.m., Church House, Westminster, London, S.W.1.

Chemical Society

March 9. 'Elimination Reactions of Quaternary Ammonium Compounds and Amine Oxides,' by J. McKenna, 5 p.m., University Chemical Laboratory, Lensfield Road, Cambridge.

March 11. 'Study of Rapid Chemical Reactions,' by Prof. G. Porter, 5 p.m., Dounreay Experimental Reactor Establishment, Aberdeen.

March 18. 'Polyethers,' by Prof. G. Gee, 6.30 p.m., King's College, Newcastle upon Tyne.

Society of Instrument Technology

March 10. 'Electro-magnetic Flow Meters,' by L. M. Bennett, 6.30 p.m., Central Library, St. Peters Square, Manchester 1.

March 18. 'Operating Experiences on Automatic Control of Large Steam Generators,' by J. S. Holt, 7 p.m., King's College, Newcastle upon Tyne.

March 19. 'Flow Measurement: Some Problems and Devices of Special Interest,' by W. J. Clark, 7.30 p.m., Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough.

March 25. 'Instrumentation of a Nuclear Power Station,' by K. R. Sandiford, 6.45 p.m., Welsh College of Advanced Technology, Cardiff.

April 1. 'Instrumentation and Automatic Control at I.C.I., Billingham,' by C. H. Gregory, 7 p.m., The University, St. George's Square, Sheffield 1.

Institute of Metals

March 12. 'The Rare Metals Used in Atomic Energy Applications,' by L. R. Williams, 7 p.m., University of Liverpool, 146 Brownlow Hill, Liverpool 3.

March 19. 'Vacuum Melting of Steel,' by J. W. S. Stafford, 7.15 p.m., The University, Southampton.

Institution of Mechanical Engineers

March 25. 'Problems of Lubrication at High Temperatures,' 6 p.m., 1 Birdcage Walk, Westminster, London, S.W.1.

Society of Engineers

April 6. 'Sonics,' by G. Constantinesco, 5 p.m., The Geological Society, Burlington House, London, W.1.

Society of Chemical Industry

April 3. 'Titanium and its Alloys as Materials of Construction for Chemical Plant,' by Dr. K. W. J. Bowen, 6.30 p.m., The University, Oxford Road, Manchester 13.

Institution of Plant Engineers

March 18. 'Some Applications of Plastics in Industry,' by Dr. C. L. Child, 7 p.m., Kings Head Hotel, High Street, Rochester, Kent.

WHAT'S NEWS about

★ Plant
★ Equipment
★ Materials
★ Processes

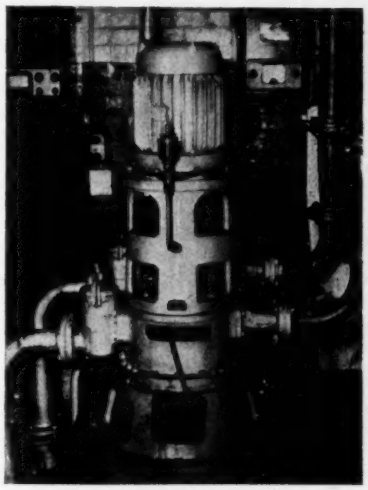
This illustrated report on recent developments is associated with a reader service that is operated free of charge by our Enquiry Bureau. Each item appearing in these pages has a reference number appended to it; to obtain more information, fill in the top postcard attached, giving the appropriate reference number(s), and post the card (no stamp required in the United Kingdom).

EIGHT YEARS OF SLAVERY–PUMPS STILL CAREFREE

In eight years of continuous service with Williams (Hounslow) Ltd., Middlesex, two British LaBour G-type vertical pumps handled 208 million gal. of works effluent which has a *p*H range of 3 to 12 before treatment. They work for 100-hr. week, the total maintenance cost has been £32 10s. and the original casings are still in use.

The makers report that a number of other LaBour pumps are in use there, one on 13% sulphuric acid, and all have very low maintenance costs.

CPE 1171



Vertical effluent pump.

Acid-resistant troughs

Etching troughs in polyester/glass, replacing teak, have recently been installed at Sun Printers Ltd., Watford, to overcome corrosion problems encountered when etching and cleaning off cylinders.

Each trough consists of two parts, one made to slide into the other, so that the various sizes of cylinder can be accommodated. Splash-ends prevent acids spilling on to the auxiliary equipment. Holes in the bottom of each trough allow acids to drain away. Covers have been moulded to fit the gearbox and drive which revolves the cylinder in the trough.

The troughs remain unaffected by such chemicals as iron perchloride, hydrochloric acid, the toluol group of solvents, acetic acid, methylated spirit and caustic soda. The troughs were moulded by Wemyss Woodhouse Ltd., Watford, using a chemically resistant *Cellobond* polyester resin and glass fibre produced by British Resin Products Ltd. A special modifying agent was added to the resin to give the required degree of resistance.

CPE 1172

Checks on dryness

A recording hygrometer which gives full-scale deflection for readings of 5% R.H. or less and warns of any increase in humidity in less than a second is produced by Shaw Moisture Meters. It can be used, among other things, for checking the humidity of dry gases.

The small detecting element consists of a capacitor with a hygroscopic dielectric only a few microns thick, covered with 24-carat gold. The detector is contained in a small, fine wire-gauze protector which plugs into a coaxial cable connecting it to the recorder. The detecting element is 1 cm. in diam. and 6 cm. long and can be used with any length of cable. An element for use in industrial driers at temperatures up to 150°C. is available.

CPE 1173

Air filters

New types of air filters, the V4 and V5, have been produced by Fibreglass Ltd. in a wide range of sizes and thicknesses. The matrix is new, consisting of *Fibreglass* tissue in a corrugated multi-layer form, and high resistance to attack by most chemicals is claimed. The filter medium will not felt in humid conditions and, because it contains no organic fibres, the fire risk is reduced.

Dust tests show that the initial efficiency is 90% for the V4 and 98% for the V5. Initial resistance at 300 ft./min. of the V4 is 0.08 in. w.g. and of the V5 0.28 in. w.g. No maintenance is required and, because of their low resistance, only low fan horse-power is needed.

CPE 1174

BUSHES AND BEARINGS

Used in the past for roller-mill bearings, *Orkot* fabric-reinforced resin now appears as a useful material for bushes for conveyors, effluent equipment and numerous other types of plant. *Orkot* bushes are available in sizes from ½ in. internal diameter and $\frac{1}{16}$ in. wall thickness.

Light and strong, the material has an unusually low coefficient of friction with the majority of lubricants and is claimed to be unaffected by most solvents, inorganic solutions, fats, weak acids and alkalis. Like other synthetic resins it has a low thermal conductivity. Manufacturers are United Coke & Chemicals Co. Ltd.

CPE 1175

C.P.E.'S MONTHLY REPORT AND READER SERVICE

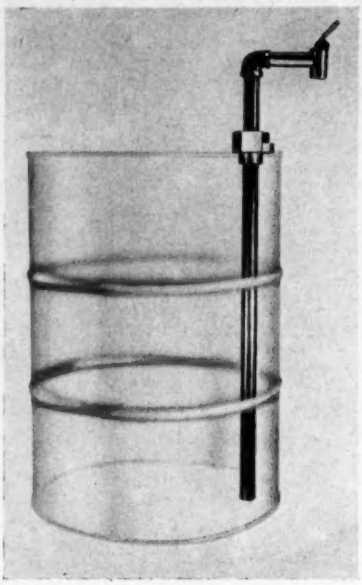
Makes a steady job of emptying barrels

An air-operated, automatic barrel dispenser delivers liquids without fluctuation or pulsing at the rate of 15 gal./min., dependent on the type of vessel and the viscosity. There are no moving parts other than the delivery valve, which is manually operated, and no vanes, rotors or pockets where contamination could take place. To change the liquid it is only necessary to flush out.

The dispenser, by Suba Hydraulics, consists of a solid-drawn steel tube riser pipe with aluminium valve body, air regulator body and barrel adaptor. The valves, stems and air regulator piston are made in brass, and the delivery valve gives minimum drip after serving. The dispenser can be made in stainless steel or other materials where required. The barrel adaptor on the standard model fits 2 in. B.S.P. thread; the air regulator has a $\frac{1}{4}$-in. B.S.P. female thread.

No storage vessel is subjected to more than 5 p.s.i. pressure. An excess-pressure safety valve is fitted to bleed away excess air pressure in the unlikely event of the air control valve not functioning.

In operation, the barrel cap is opened, the dispenser screwed in and connected to an air supply. No priming is necessary and the instrument will never dry out. Once charged it will maintain its own pressure until an appreciable drop in level is reached. **CPE 1176**



Barrel dispenser.

KEEPING LIQUID ON THE LEVEL

Wherever a constant liquid level is required, a new controller, Model No. 614, manufactured by Liquid Systems Ltd., can easily be adjusted to suit varying needs. All parts coming into contact with solution are resistant to corrosion so that flow to the tray cannot be restricted by deposits and the tray cannot overflow.

The 1-gal. polythene bottle is fitted into a mild-steel holder which, though secured to the main bracket, can be removed to enable the unit to be attached to a machine by fixing two set screws through the bracket, slotted holes enabling slight adjustments in level to be made.

The reservoir cup is PVC-coated aluminium and is fastened to the aluminium main bracket. The valve is spring loaded to prevent loss of fluid when inverting the container, and opens when the container is replaced. **CPE 1177**

DRIES A CUBIC FOOT

A small, self-contained drying unit for processing powders, filter cakes, granules, etc., has been produced by Dunford & Elliott Process Engineering Ltd. as a packaged version of their rotary-louvre continuous drier. It can be used for preliminary testing or for the rapid and continuous handling of small quantities of materials. It is capable also of roasting and cooling.

This packaged drier holds up to about 1 cu. ft. of material and the drying time may be varied between 5 and 60 min. Under favourable conditions it can evaporate 100 lb./hr. of free water.

The unit consists basically of a 3 ft. 6 in., rotary-louvre, horizontal drum mounted on four adjustable supporting rollers and driven by a $\frac{1}{2}$-b.h.p. motor. Inlet and exhaust fans are powered by a 1-b.h.p. motor with a vee-rope drive. There is an air heater of the 'direct' type and the combustion chamber is fitted with a *Hypact* burner and hand control cock while a *Tubix* dust collector is attached to the exhaust hood.

Moisture reductions achieved with inlet temperatures of from 120 to 300°C. include cellulose acetate, 72.9 to 2.0%; dicalcium phosphate, 5 to 0%; polystyrene, 20.8 to 1.42; and sulphate of ammonia, 2.5 to 0.1%. The unit may be operated at any temperature of inlet air up to 450°C. **CPE 1178**

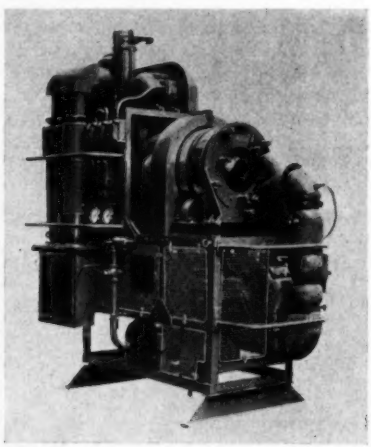
Indicating temperature controllers

Temperature controllers comprising mercury-in-steel actuated 4-in. dial thermometers with control units having one temperature-operated pointer and one or two adjustable pointers which can be set to 'make' and/or 'break' are manufactured by the British Rototherm Co. Ltd. Standard energising coils operate on 100 to 440 v. a.c. 50 c/s. A mercury relay switch is incorporated. The minimum differential is $\pm 0.5\%$ of scale range. Switch contacts can be set normally open, normally closed or changeover. **CPE 1179**

Dry lubrication

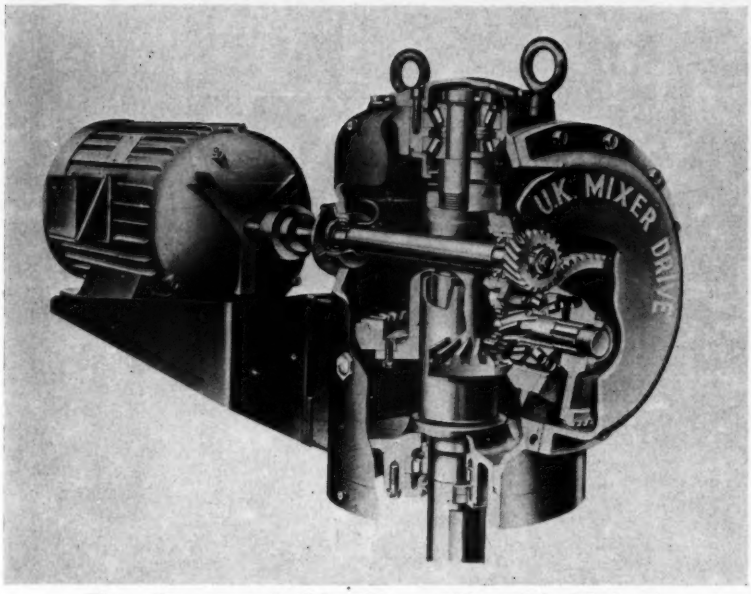
Self-propelled, pressurised, 12-oz. aerosol containers are now available for molybdenum disulphide. They incorporate internal agitators and spray a solid film of lubricant which is suitable as an anti-seize material for hot and cold screw threads, as running-in material for machinery components, as a dry lubricant for instruments and precision mechanisms, etc.

The film has an operating range of from −200 to +700°F., making it suitable for dry lubrication of electrical and aircraft mechanisms, linkages, and for anti-friction bearings and gears operating at elevated temperatures. Manufacturers are K. S. Paul (Molybdenum Disulphide) Ltd. **CPE 1180**



Packaged rotary-louvre drier.

SPECIAL DRIVES FOR MIXERS



The entire crown-wheel bearing assembly may be lifted out.

Spiral-bevel agitator drives for fluid mixing operations have been developed by the newly formed U.K. mixer division of Stockdale Engineering Ltd.

There are five standard units for both open and closed tank operation, and the drive assembly can be ' tailor made ' to meet highly specialised process requirements.

The agitator shaft which transmits power from the prime mover to the impeller has been designed for maximum rigidity and minimum deflection between bearings. For this reason long, overhung shafts can be used at speeds higher than usual without approaching the critical or shaft whirling speed which can set up excessive vibrations and so cause mechanical troubles.

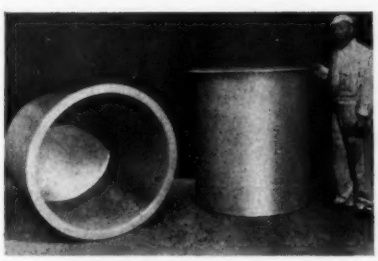
Variable mixing speeds are required in some processes and for this reason helical-spur ' pick-off ' input change gears are fitted, and these can be changed without removing the drive or impeller shaft assembly from the vessel. Access is gained simply by removing the gear casing and no special tools are required.

According to the makers, the cast-iron box construction imparts maximum operational rigidity and allows the shaft to rotate without whip at the stuffing box or mechanical seal so that little maintenance is required at this point. Furthermore, it is stated, there is no danger of the packing acting as a bearing with consequent loss of seal. **CPE 1181**

Powders get a shake on

A vibrator attachment for the hoppers of tablet-making machines is aimed at overcoming the problem of materials that do not flow through so easily. It is intended for operation on single-phase a.c. electric supply, being introduced with an isolator into the normal three-phase circuit of the machine. The wiring is such that the machine can be run without the hopper vibrator being used, but the vibrator cannot be operated without the machine being in motion, and provision is made for removal of the hopper from the machine.

Made by Manesty Machines Ltd., the vibrator has a dust-proof cover/guard and is arranged for mounting on the conical section of rotary machine hoppers above the spout. **CPE 1182**



Polythene vats.

Counts by the dozen

An electro-magnetic counter with the first wheel graduated from 0 to 11, so that the counter reads in dozens and fractions of a dozen, is announced by Counting Instruments. This Type 100 counter is claimed to be the first of its type available with either push-button or electric reset. **CPE 1183**

Pumps for silent service

High-vacuum rotary piston pumps with freedom from vibration, silent running and a very low ultimate are announced by Genevac Ltd., and are said to be well suited to laboratory conditions. The single-stage pump is available in capacities of 2, 4, 8 and 12 cu.ft./min. with an ultimate vacuum of less than 0.005 mm. Hg. The double-stage model is available for 2, 4 and 6 cu.ft./min. and has an ultimate vacuum of less than 0.0002 mm. Hg. The design permits of higher pumping speeds at 100 microns and the pressure rise is less than 0.5 mm. Hg with maximum ballast. The necessity for oil changes is reduced due to the oil circulation filter system. **CPE 1184**

Giant vats

Two moulded polythene vats manufactured by Metal Containers Ltd. recently have a circumference on the outside lip of almost 13 ft. and an overall height of 4 ft., giving a nominal capacity of 250 gal. Vessels such as this can be manufactured in cylindrical or rectangular form and may have fittings, *e.g.* threaded bosses for draw-off taps, included in the moulding. Manufactured in one piece from high-pressure polythene, they are suitable for sensitive chemicals and highly corrosive acids.

The company also supply standard cylindrical vats with nominal capacities of 50, 100, 150, 200 and 250 gal. **CPE 1185**

Rigid foam

Rigid polyurethane foams are of growing interest for heat and sound insulation and the range of densities which can be achieved by foaming *in situ* techniques using the two-component polyurethane foam systems has been extended by the introduction of *Daltolac* 24. Made by Imperial Chemical Industries Ltd., it contains not only a fireproofing agent but also

HYDRAULIC LIFT TRUCK

This Swedish BT hand-operated lift truck is unusually strong and light, and is supplied with a capacity of 2,400 *or* 4,400 *lb. A unique feature, say the distributors, Rolatruc Ltd., is the leakproof hydraulic unit. Nylon reinforced bakelite wheels or rollers can be employed on floors or other surfaces contaminated by grease, oil and most chemicals. Widths range from* 20½ *to* 27 *ins.* **CPE 1186**

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a reaction catalyst and other additives so that when 100 parts are reacted with 130 parts of *Suprasec D*, fine-textured rigid foams with densities between 1.8 and 2 lb./cu.ft. are obtained.

The catalyst used has little or no odour and allows adequate time for mixing and pouring of the foam mix. **CPE 1187**

Handles any drum that comes

A modified version of the VLL/10 drum-lifting device, by British Electrical Repairs Ltd., can handle drums of any type, size and weight. 'Pre-loading' is incorporated, adequate clamping pressure being applied before the drum leaves the floor, so eliminating load-slip and making the device suitable for snatch lifting procedure.

Whilst suspended from a crane or hoist hook prior to lifting, the clamps remain locked open, but when the device has been lowered on to the drum end, the movement of a hand lever through 190° sets the clamps in the 'pre-loading' position. As the drum is lifted, clamping pressure is further increased by the supporting lever linkage mechanism. Steel-backed bronze bearings are incorporated and are arranged for grease gun lubrication.

A power-operated model equipped with fully automatic or remote electrical control may, for example, be operated by the driver of a mobile crane. **CPE 1188**

Thickness measurement

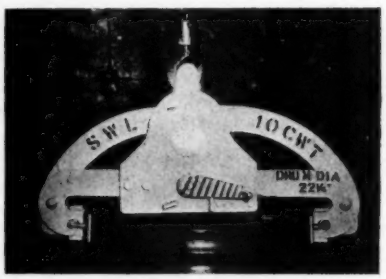
A new instrument for non-destructive testing is the *Elcotector*, which makes use of the fact that the electrical characteristics of a coil are influenced in proportion to its proximity to a metal surface. Under suitable conditions a meter is capable of translating these changes in the coil into measurements of non-metallic coating on metal. The coil is also influenced by the type and structure of the metal so that metal film thickness, metal hardness and other measurements can be made. Contained in a portable, desk-type cabinet carrying a dial, control knobs and switches, the unit has a probe attached to it by a cable. According to the manufacturers the instrument will:

(*a*) Measure metallic or non-metallic coatings on a ferrous base.
(*b*) Measure non-metallic coatings on most metal bases and some metallic coatings provided the specific resistance of the coating and the base is different.
(*c*) Compare the degree of hardness of steel components.
(*d*) Differentiate between the variations in ferrous contents in steel.
(*e*) Measure the thickness of non-ferrous foils.
(*f*) Measure any type of metallic and non-metallic film providing with the latter a metal plate can be introduced at the reverse side at the point of measurement.
(*g*) Differentiate between various types of alloys.
(*h*) Detect surface cracks.

Further information about the *Elcotector* and its uses can be obtained from the East Lancashire Chemical Co. Ltd. or by filling in the reply-paid card. **CPE 1191**

FLANGES

Forged alloy flanges for use in process and chemical equipment at high pressures and temperatures are being marketed in the United Kingdom by H. & E. Lintott Ltd. The range includes welding-neck, slip-on, lap-joint, threaded, blind, socket-type, reducing, orifice and special flanges. In size they range from ¾ in. nominal bore to 12 in., and cast fittings are available up to 48 in. diam. **CPE 1190**

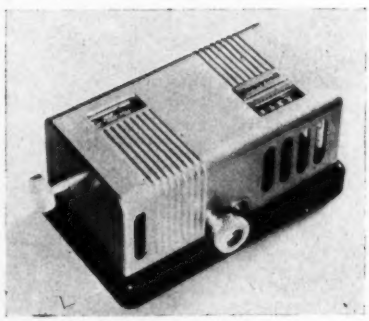


Drum lifter locked open.

COOL CONTROL FOR HEATERS

Where unit heaters and forced air convectors provide heating for factories, etc., an additional control can be used to operate the fans when the heating plant is shut down in hot weather. This is a thermostat by Honeywell Controls Ltd., which makes it possible for a unit heater installation to be run automatically, as with a conventional thermostat, or continuously regardless of temperature factors.

The new features of the thermostat are based on a three-position manual control with a locking device which prevents it being tampered with. The three positions are: 'automatic,' which brings the conventional function of the thermostat into operation; 'on,' which allows the fans of unit heaters to turn even when the thermostat is not calling for heat; and 'off,' which shuts the plant completely. **CPE 1189**



Hot weather thermostat.

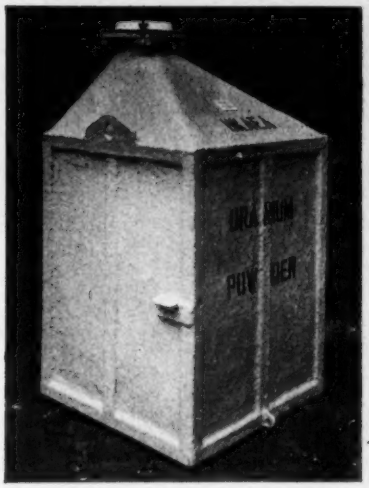
STUCK IT WELL

A new cement, Corro-Proof PXY, *has been used for chemical-resisting joints for glazed pipework, and is claimed to have withstood rigorous tests. Two 6-in.-diam. pipes were jointed in glazed condition with the cement and pressure was applied to conform to the requirements of B.S.* 1143 : 1955. *The whole (pipes and joints) having withstood this, pressure was increased to the maximum obtainable with town water,* 70 *to* 76 *p.s.i. This pressure was maintained for approximately* 1½ *hr. whilst a hand pump was introduced into the system to enable a figure of* 100 *p.s.i. to be recorded. Neither pipes nor joints showed leakage or failure, say the makers of the cement.* **CPE 1193**

LOW-COST TREATMENT OF INFLAMMABLE SOLVENTS

The running costs of this new distillation unit for treatment of inflammable solvents are reported to be almost negligible when it is connected to a steam line, saturated or superheated, and the exhaust steam is fed back to a heating system, washing plant or auxiliary machine. Known as the Schlegel D.E. 200, *the unit comprises a well-insulated distilling chamber of* 44 *gal. capacity with a water-cooled condenser; it can be fitted with either a manual or automatic temperature regulator.* **CPE 1192**

STORAGE CONTAINERS



Containers manufactured from Fibreglass *and bonded with polyester resin are available for the storage and handling of corrosive and dangerous powders. The strength of these containers can be judged from the photograph showing a* 2 *ft.* × 2 *ft.* × 2 *ft.* 7 *in. deep container built to hold* 900 *lb. of uranium powder.*

The containers may be stored in the open, since the mild-steel angle frame is completely sealed in the glass fibre/polyester resin. The flange is moulded from Fibreglass *also and employs a pressed PVC cap which is secured by eyebolts and wingnuts, a* Neoprene *gasket ensuring that the containers are airtight.* **CPE 1194**

★ *American Developments in Brief* ★

A screening machine with a multiple whirlpool action that is adjustable both in amplitude and speed is the *Vorti-Siv*, made by J. M. Lehmann Co. Inc. It screens powders, liquids and slurries in meshes from 4 to 400, occupies 4 sq. ft. and is portable. **CPE 1195**

* * *

A barrier coating to protect concrete, brick, cement block and other surfaces in heavy chemical exposure has been produced by Pennsalt Chemicals Corp., specifically for protection of pump bases, column pedestals, trenches, wall and floor areas under tanks and process equipment where excessive wear is not encountered. Another grade is formulated to protect the same areas in very corrosive atmospheres where hydrofluoric acid and fluorides are present, while a third coating is for trowel application on floors subjected to abrasive wear in addition to corrosive chemical conditions. **CPE 1196**

* * *

It is estimated that annual savings of $10,500 to $14,000 have been achieved by the application of *Hypalon* synthetic rubber coating to the lead cooling coils in a stirring kettle which holds a brine of 20% sulphuric acid containing some 3% sodium chloride. Temperature of the brine is 95 to 98°C. and attack by hydrochloric acid and abrasion from crystals formed in the process previously caused failure of the lead pipes after 20 to 40 cycles. Three coats of *Hypalon* kept the coils in good condition for a much longer period. Other successful applications of *Hypalon* maintenance coatings, including an iron centrifuge, a steel filter-press housing, pumps and a cooling tower, are reported by the elastomer chemicals department of E. I. du Pont de Nemours & Co. **CPE 1197**

* * *

The *Duplex Disperser* is a flexible, compact batch mixer that combines a powerful disperser head with a rugged, diamond-shaped agitator to produce finished homogeneous batches without further processing for most chemicals, plastics, inks, pharmaceuticals, paints and industrial finishes. A high degree of shear, kinetic impingement and complete mulling action for better wetting are claimed by the manufacturers, Troy Engine & Machine Co. **CPE 1198**

Recent British Patents

Production of uranium

The reaction between a uranium halide, such as the tetrafluoride, and a metal such as calcium, is autothermic and, once initiated, generates a high temperature of the order of 1,400°C. It is therefore difficult to find a suitable material of which to construct the reaction vessel. In the first of two patents, at least that part of the vessel in contact with the reaction mixture has a lining of calcium fluoride. This lining is prepared by mixing precipitated calcium fluoride, or ground fluorspar of good quality, with water, preferably containing a dissolved alkaline earth metal chloride, to form a plastic mass, which is applied to the interior of the reaction vessel, with the aid of a former. The vessel is dried evenly and then baked at 200 to 250°C., to render the exposed surfaces anhydrous. The lining is so shaped that there is a small well at the bottom into which molten metal can flow. The latter is thus prepared and cast in one operation. The state of division of the calcium fluoride is important. A schedule is given of proportions thereof which should be retained by sieves of various meshes.

In the second of two examples, 2 cwt. of fluorspar were mixed with 1.5 gal. of 19% aqueous solution of magnesium chloride. This mixture was tamped round a wooden former in a mild-steel frustoconical canister to give a lining between 2 and 2½ in. thick. A cylindrical well was provided, 3½ in. high and 4½ in. in diameter. The lined canister was heated for three days at from 100 to 200°C., and the inside surface was then heated by a gas flame for 42 hr. A mixture of 25.1 lb. of calcium turnings with 55.3 lb. of anhydrous uranium tetrafluoride, containing 75.0% of uranium, was placed in the vessel. Argon was blown in through a dip pipe for 10 min. The dip pipe was removed and in its place was inserted a mixture of starch and potassium chlorate with a copper wire which, on passing an electric current through it, became red hot and initiated the reaction. The reaction time was from 2 to 3 min. After cooling, the slag and metal were removed without destroying the lining, which had been eroded in the lower portion to a depth of ¼ in. The uranium obtained weighed 39.3 lb., and was of 99.4% purity.

The process described above sometimes results in unaccountable failures, in that the metal is of low yield, or unsatisfactory quality, or both. The second patent has the object of eliminating this drawback, by regulating the shape and size of the calcium turnings and the free space between them in relation to the volume occupied by the uranium tetrafluoride.

According to the invention the calcium, in excess, is in the form of plate-like pieces, and has a packing density such that the free space between the pieces of calcium is substantially equal to the volume occupied by the uranium tetrafluoride. The calcium turnings are between ½ and 1 in. long, between ¼ and ½ in. wide, and between $\frac{1}{32}$ and $\frac{1}{80}$ in. thick.—805,191 *and* 805,192, *United Kingdom Atomic Energy Authority.*

Fusion kettle

For melting naphthalene and other substances a fusion kettle has been designed to minimise the fire hazard and the escape of vapour associated with open kettles.

The new type of kettle has a domed upper part, in which there is a feed hopper with a hinged lid provided with a handle. The hopper directs the charge to the central portion of the kettle, which is fitted with a heating coil, integral with a cover so that both may be removed for cleaning. The floor, which is slightly conical, has an outlet pipe for molten materials, and the dome a vapour outlet pipe. Glass inspection windows can be arranged in required positions. A perforated plate in sections, which rests above the heating coil, may be inserted or withdrawn through an opening by which the coil and cover may be removed for cleaning. A drawing is appended to the specification.—803,269, *Union-Chemie Ernst Paul Jager Import-Export Chemischer Anlagen & Rohstoffe (Germany).*

Gasification of carbonaceous material

The invention is claimed to overcome some difficulties of previous processes, and provides a method by which hot gases from high-temperature gasification are cooled by finely divided carbonaceous material, so that the gases are cooled by heat exchange. The carbonaceous material is separated and cooled by partial reaction with steam and/or carbon dioxide, and is then reintroduced into the hot gases.

The plant, illustrated by a drawing, consists of a long vertical vessel into which the carbonaceous material, steam, and air or oxygen are introduced through separate conduits. The carbonaceous material is gasified while fluidised, and liquefied ash is run off from a conduit at the bottom of the vessel. In a separate vessel, carbonaceous material, in a fluidised bed, is treated with steam and/or carbon dioxide and conveyed into the vertical vessel so that it becomes suspended in the hot gases. It is carried to the upper part of the vessel and the gases, now cooled by heat exchange, pass to a cyclone, which they leave by an upper outlet. The separated solid matter descends through another outlet, passes through a conduit, and thence into the fluidised bed in the aforementioned separate vessel, for further reaction with steam and/or carbon dioxide.—803,234, *The Gas Council, West Midlands Gas Board, F. J. Dent and R. T. Stuart.*

Acid inhibitors for pickling baths

The use of mineral acid pickling baths for removing scale and other foreign matter from metal surfaces has long been known, as has the addition of inhibitors to the baths to minimise the attack of the acid on the metals themselves. However, conventional inhibitors are effective only with iron or steel. It is the object of the present invention to provide inhibitors for protecting other metals such as aluminium and zinc. This is claimed to be accomplished by the use of at least one free aromatic or aryl-aliphatic aldehyde in conjunction with at least one free basic aromatic compound, or salt thereof, containing nitrogen.

Suitable aldehydes are benzaldehyde, furfuraldehyde, phenylacetaldehyde, and alpha-naphthaldehyde. The basic aromatic compound containing nitrogen may be nicotine, cinchonine, aniline, quinoline, or a salt of any of the above. The proportion of inhibitors used is, on the average, 0.03 mol of the aldehyde and 0.01 mol of the nitrogenous compound per litre of the pickling mixture.

In the last of 16 examples, an inexpensive formulation for pickling aluminium consists of 100 c.c. of 10% aqueous hydrochloric acid, 0.3 g. of benzaldehyde and 0.1 g. of aniline.—803,541, *Technion Research & Development Foundation Ltd. (Israel).*

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